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FORM PTO-1390 (REV. 9-2001) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY 'S DOCKET NUMBER: 3330

U S APPLICATION NO (If known, see 37 CFR 1 5: Not assigned 09/926310

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/EP 00/03713	13 April 2000	13 April 1999

TITLE OF INVENTION
FOOD PRODUCT WHICH ARTIFICIALLY HAS BEEN GIVEN A GELL-LIKE STRUCTURE BY ETC

APPLICANT(S) FOR DO/EO/US
OLE-BENDT RASMUSSEN

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [XX] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371
3. [XX] This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. [XX] The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. [XX] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [ ] is attached hereto (required only if not communicated by the International Bureau).
   b. [XX] has been communicated by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [XX] An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a [ ] is attached hereto.
   b. [XX] has been previously submitted under 35 U.S.C. 154(d)(4). by the International Bureau
7. [X] Amendments to the claims of the International Aplication under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are attached hereto (required only if not communicated by the International Bureau).
   b. [ ] have been communicated by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired
   d. [ ] have not been made and will not be made.
8. [ ] An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. [XX] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [ ] An English lanugage translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. [ ] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [XX] A FIRST preliminary amendment.
14. [ ] A SECOND or SUBSEQUENT preliminary amendment.
15. [ ] A substitute specification.
16. [ ] A change of power of attorney and/or address letter.
17. [ ] A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1 825
18. [ ] A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. [ ] A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4)

· items or information:

09926310 . 101101

JC08 Rec'd PCT/PTO 11 OCT 2001

U.S. APPLICATION NO. (if known, see 37 CFR 1.5) 09/926310	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER

21. [XX] The following fees are submitted:	CALCULATIONS	PTO USE ONLY
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1040.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$890.00**	$890.00	
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$740.00**		
International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$710.00**		
International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$890.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	$	
Total claims	70 - 20 =	50	x **$18.00**	$ 900.00	
Independent claims	5 - 3 =	2	x **$84.00**	$ 168.00	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)		0	+ **$280.00**	$ -0-	
TOTAL OF ABOVE CALCULATIONS =				$	
[ ] Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2. +				$ 1,958.00	
SUBTOTAL =				$	
Processing fee of **$130.00** for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				$	
TOTAL NATIONAL FEE =				$ 1,958.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$	
TOTAL FEES ENCLOSED =				$ 1,958.00	
				Amount to be refunded:	$
				charged:	$

a. [XX] A check in the amount of $ 1,958.00 to cover the above fees is enclosed.

b. [ ] Please charge my Deposit Account No. ______________ in the amount of $ __________ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [XX] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 04-0070. A duplicate copy of this sheet is enclosed.

d. [ ] Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

SIGNATURE

WILLIAM J. DANIEL

NAME

16,585

REGISTRATION NUMBER

09/926310
JC08 Rec'd PCT/PTO 11 OCT 2001

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re New Application of:

OLE-BENDT RASMUSSEN

Filed: Concurrently

S. N. Not assigned

Corresponding to International Application **PCT/EP 00/03713**

For: **FOOD PRODUCT WHICH ARTIFICIALLY HAS BEEN GIVEN A CELL-LIKE STRUCTURE BY COEXTRUSION OF SEVERAL COMPONENTS, AND METHOD AND APPARATUS FOR MANUFACTURING SUCH PRODUCT**

McLean, Virginia 22101
October 4, 2001

PRELIMINARY AMENDMENT

Hon. Commissioner of Patents and Trademarks
Washington, D. C, 29231
Sir:

In advance of the calculation of the filing fee for the above-identified new application, please amend the application as instructed below. Applicant's attorney has been advised that an amendment was submitted by applicant's British Patent Agent to the European Patent Office under date of 19 June, 2001, making minor corrections in the specification and claims. But he has no information whether that amendment has been transmitted to the USPTO. He has consulted with "PCT HELP DESK" and the very helpful representative recommended that to avoid confusion, all of the claims, either as originally filed or as amended in the European Patent Office, as the case may be, be canceled and new claims incorporating the changes deemed by applicant's attorney to be needed be substituted, which is being done herewith.

However, prior to receiving this suggestion, the claims as worded in the original application as transmitted by the International Bureau had been amended according to the normal procedure, i. e. bracketing deleted matter and underlining added language. The "HELP DESK" agreed with applicant's attorney's opinion that it would likely be helpful to the Examiner to have a copy of the amended version before him and. accordingly, it is being included following the substituted new claims.

IN THE CLAIMS:

Cancel all of the claims in the case and substitute the following new claims:

--106. A three-dimensional food product, elongated in at least the z-dimension and consisting of at least two components A and B which have been coextruded to become interspersed with each other, in which a plurality of cells of component A are surrounded at least in the xz plane by at least one component B which forms cell walls surrounding the A component, wherein said B component is a solid (including a viscoelastic solid) at 20° C, the cells of component A are arranged in at least two mutually distinct rows extending generally in the z direction, each said row of cells being separated from each adjacent row by a generally continuous in the z direction boundary cell wall of said B component, and either a) component A is a fluid having no compressional yield point at 20° C or is a solid having plastic, pseudoplastic or viscoelastic consistency at 20° C and a compressional yield point (YPB_{20}) at 20°

C which is less than 0.5 x the compressional yield point of B at 20° C (YP_{B20}), or b) component A is an expanded material containing at least 50% by volume gas.

--107. A product according to claim 106 having two generally opposite xz faces and in which each cell of component A extends in a generally y direction substantially from a position at least adjacent to one xz face of the food product to a position at least adjacent to the other xz face.

--108. A product according to claim 106 in which there are two different B components B_1 and B_2 and the boundary cell wall is formed of said first component B_1 and the product has bridging cells walls branching from said boundary cell wells and extending at least part way in a generally x direction towards the adjacent boundary cell wall, the bridging cell walls being form at least in part of component B_2.

--109. A product according to claim 106 in which the components B_1 and B_2 have different yield points at 20° C.--

--110. A product according to claim 109 in which the yield point of component B_1 at 20° C ($YP_{B1(20)}$)) is in the range of 0.1 to 0.5 of the yield point of B_2 at 20° C (YPBP(20).

--111. A product according to claim 106 which has two generally opposite xz faces and each of the cells of component A extends part way between said two xz faces with at least two of said cells spanning the distance between the two xz faces, all of the cells being separated from one another in the y-direction, and B components are arranged between adjacent cells of component A and

are separated from one another generally in the y direction to form cell walls around each component A cell, so that the A component cells are substantially enveloped by cell walls of component B.

--112. A product according to claim 111 having two different B components B_1 and B_2 in which the B component between adjacent cells of the A component separated in the y-direction comprises component B_1.

--113. A product according to claim 106 in which there are bridging cell walls branching from said boundary cell walls separating adjacent rows of A component cells and extending at least part way in a generally x direction toward an adjacent boundary cell wall and between cells of A component in said rows, and said boundary cell walls and said bridging cell walls are formed of the same B component.

--114. A product according to claim 106, characterized in that any attenuation in the thickness of said bridging cell walls in the vicinity of a boundary cell wall has a local thickness generally not any thinner than 1/15 of the thickest portion thereof.

--115. A product according to claim 113 in which said boundary walls of B-component extend in waved or zig-zagging manner about a plane extending in the zy plane.

--116. A product according to claim 106 which has bridging cell walls formed of a component B branching from said boundary cell walls and extending at least part way in a generally x direction toward an adjacent boundary cell wall and the bridging

cell walls which branch off from the boundary cell walls, considered in a yz plane, branch off substantially perpendicularly to the boundary cell wall at the branching points thereof.

--117. A product according to claim 107 which further comprises surface boundary walls of a component B extending substantially continuously generally at least adjacent to each xz face thereof.

--118. A product according to claim 106 in which each boundary cell wall separating adjacent rows of cells of said component A is substantially planar.

--119. A product according to claim 106 in which the cross section of said cells of component A in the xz plane has an average dimension in the z-direction in the range of 0.5 to 10 mm.

--120. A product according to claim 106 in which the average cross-sectional area of said cells of component A in the xz plane is in the range of 0,5 - 100 mm^2.

--121. A product according to claim 106 in which the average separation between adjacent rows of said cells of said component A is in the range 1 - 25 mm.

--122. A product according to claim 121 in which the boundary cell walls of said component B separating adjacent rows of said cells of component A have a minimum thickness in the x direction in the range 5 - 50% of the average separation between adjacent rows.

--123. A product according to claim 116 in which the bridging cell walls have a minimum thickness of 0.1 mm.

--124. A product according to claim 106 wherein component A in the final form of the product at 20° C is fluid.

--125. A product according to claim 106 wherein component A in the final form of the product at 20° C is a plastic, pseudoplastic or viscoelastic material having a compressional yield point, YP_A lower than 1000 g cm^{-2}.

--126. A product according to claim 125 wherein component A comprises a blend of solid particles selected from the group consisting of short fibres, nut- grain- or shell-pieces, film-pieces or flakes, with a water based solution or gel.

--127. A product according to claim 125 wherein component A comprises a blend of solid particles selected from the group consisting of short fibres, nut-, grain-, or shell-pieces, film-pieces or flakes with an oil.

--128. A product according to claim 106 wherein component B is in the form of a gel.

--129. A product according to claim 106 in which component B including a component B reinforced with solid particles selected from the group consisting of short fibres, or grain-, shell- or film-pieces or flakes, has a yield point YP_B, of at least 200 g cm^2.

--130. A product according to claim 106 wherein component B is comprised of fat, oil or wax with flavoring additives .

--131. A product according to claim 106, wherein component B comprises protein .

--132. A product according to claim 106, wherein component B is a microporous agglomerate of particles containing water in the

pores, said particles being selected from the group consisting of short fibres or grain-, shell- or film-pieces or flakes and are bonded together by micro-stands of a polymer selected from the group consisting of coagulated gluten or a natural or synthetic rubber as produced by coagulation of a latex.

--133. A product according claim 106 wherein component B comprises a gel of a polymer selected from the group consisting of carbohydrates or carbohydrate related compounds.

--134. A product according to claim 106 wherein component B comprises a polymer and in the boundary cell walls of said polymer B extending in a generally z direction the molecules thereof are molecularly oriented generally in the z direction.

--135. A product according to claim 106 wherein component A is a juice containing dissolved sugar and is in form of a flowable soft gel or thick liquid thickened with a thickening agent.

--136. A product according to claim 106 wherein component A is a juice in the form of a soft gel or a thick liquid thickened with a thickening agent and contains hydrolysed proteins to in sufficient amount to impart taste and nutritional value.

--137. A product according to claim 106 wherein component A contains a pulp of subdivided protein fibres or film.

--138. A product according to claim 106 wherein component A is a cultured milk product.

--139. A product according to claim 106 wherein component A is marzipan.

--140. A product according to claim 106 wherein component A comprises a meat paste.

--141. A product according to claim 106 wherein the A component contains gas dispersed therethrough.

--142. A product according to claim 141 which is a bread or cake and component A comprises expanded and baked starch and B comprises protein.

--143. A product according to claim 141 wherein component B comprises cheese.

--144. A product according to claim 106 wherein component A has two different components, A1 and A2.

--145. A product according to claim 144 in which component A1 comprises a waterbased solution or gel forming a matrix for solid particles, and A2 comprises fat or oil forming a matrix for solid particles.

--146. A food product which is a three dimensional solid at 20° C and is elongated in at least the z-dimension and consists of at least two components A and B which have different visual appearances and have been coextruded to intersperse segments of A and segments of B, wherein each B component is a solid at 20° C and each A component is a solid at 20° C, the segments of component A are arranged in at least two mutually distinct rows extending generally in the z-direction, and the rows of segments of component A and interspersed segments of component B are visible at at least one surface of the product extending generally in a xz plane.

--147. A product according to claim 146 in which the segments of component A and segments of component B are attenuated in their minimum thickness adjacent their ends as compared to their thickness at points intermediate their ends and in which the segments are dragged out during their coextrusion so as to form an acute angle of less than about 45° with the z-direction in the xz plane.

--148. A product according to claim 146 in which component A and component B are selected from the group consisting of [consist of one of] the following combinations:

a. dark chocolate/ light chocolate

b. chocolate/marzipan

c. chocolate/caramel

d. two differently coloured edible gums or fruit gels.

--149. A method of manufacturing by coextrusion of a plurality of extrudable edible components in an extrusion die a solid food product in which the components are extruded in a z-direction from the extrusion die and exit therefrom, and in which at least one extrudable component A' is formed into a flow through a channel and an extrudable component B' is formed in a flow through a channel, the flow of B' being in generally an x direction transverse to said z direction adjacent the flow of A', in which after exiting from said die, the flows of A' and B' are regularly divided generally in said x- direction by a dividing member to form at least two rows of flows of A' and B' separated in the x-direction, in each of which rows the flows of A' and B' are

segmented in the z direction with a segment of flow of B' being joined upstream and downstream to each segment of flow of A', whereby B' segments are interposed between adjacent A' segments in the z direction and in which adjacent rows are joined to one another along their yz faces, and wherein after the joining of the segmental flows B' is transformed to a normally solid material having a compressional yield point which is at least twice that of B'.

--150. A method according to claim 149 in which after the segments of flows are joined, the material A' is expanded to at least twice its original volume, or material A' is treated to reduce its yield point, if material A' is solid, or its apparent viscosity, if material A' is liquid, by at least one-half.

--151. A method according to claim 149, wherein the extrusion is carried out at an elevated temperature and material B' is treated by cooling.

--152. A method according to claim 149 wherein material B' is treated for form a coagulate or gel.

--153. A method according to claim 152 wherein material B' is heated to form the coagulate or gel.

--154. A method according to claim 152 wherein material B' normally has a continuous, firm gel structure and prior to its coextrusion is converted into extrudable form by disruption to a finely divided condition, and after the end of the coextrusion, material B' is treated to reestablish its continuous firm structure.

--155. A method according to claim 152 wherein material B' is treated by chemical reaction to form the coagulate or gel.

--156. A method according to claim 155 wherein a gelling reagent or coagulant is incorporated into material B' prior to the extrusion process and the rate of gelation or coagulation is retarded to delay gelation or coagulation until after the completion of said joining of said flows.

--157. A method according to claim 156 in which said reagent or coagulant is incorporated into solid particles suspended in material B'.

--158. A method according to claim 156 in which material B' is adapted to undergo gel formation or coagulation by enzymatic action and the gel formation or coagulation is carried out by means of an enzyme.

--159. A method according to claim 152 wherein material B' is adapted to undergo gel formation or coagulation by action of a reactant and said reactant is incorporated in the material A', thereby gradually migrating into material B' when materials A' and B' are brought together in the coextrusion die.

160. A method according to claim 149 in which both material A' and material B' are each formed into at least two flows separated from one another in the x direction and in which flows of material B' are partially interposed between adjacent flows of material A'.

161. A method of coextruding at least two extrudable materials A' and B' in an extrusion die which comprises the steps

of supplying at least one material A' from a reservoir therefor and advancing the same by extrusion pressure as a flow through one extrusion channel and out of an exit from the channel end, and supplying at least one material B' from a reservoir therefor and advancing the same by extrusion pressure as a narrow flow through a separate extrusion channel and out of an exit from the channel end; dividing each of the flows of materials A' and B' not prior to the respective channel exits into segments of the respective extrudates by a dividing member therefor, each said dividing member moving relative to the corresponding channel exit to traverse the entire channel exit; and controlling the flows of both materials A' and B' out of the extrusion channel exit to cause said flows to be intermittent in nature in synchronism with the movement of said dividing members.

--162. The method of claim 161 wherein said flows of said materials A' and B' are controlled to cause the respective materials to flow from the corresponding channel exits when said dividing members are in said first and second positions but not when said dividing members are moving across said channel exits.

--163. The method of claim 161 in which said flows of said materials A' and B' are controlled to take place intermittently by periodically applying and releasing said extrusion pressure to the respective materials in the corresponding channels.--

--164. The method of claim 161 in which said flows of said materials A' and B' are controlled to take place intermittently by

periodically blocking and opening the channel exits to prevent said materials from exiting therefrom.

165. A method according to claim 161 including the additional step of joining together the segments of said materials A' and B' after their formation by said dividing member so that segments of material A' alternate with segments of material B'.

--166. A method according to claim 162 in which the relative movement of said dividing members with respect to said channel exits creates a plurality of adjacent rows of segments of material A' and segments of material B' joined to the segments of material A' in said rows.

--167. A method according to claim 149 which comprises the further step of collecting the rows of segments of materials A' and B' after they are joined, in a collection chamber in the form of a sheet.

--168. A method of manufacturing by coextrusion in sheet, ribbon or filament form of a food product which is normally solid at 20° C and is comprised of at least two components A and B in segment form, wherein segments of component B are in contact with segments of component A, which comprises extruding flows of an extrudable component A pre-cursor A' and of an extrudable component B pre-cursor B' from separate orifices of an extrusion die, sub-dividing each of said flows into segments and combining said sub-divided flows in rows with the segments of pre-cursor B' generally alternating with segments of pre-cursor A' and, after extrusion, converting said pre-cursor B' to a solid material B, in which

extrudable pre-cursor B' is adapted to be rendered normally solid by coagulation or gel formation and a coagulant or gelling reagent is incorporated in pre-cursor A' whereby when said segments of pre-cursor B' are in contact with segments of pre-cursor A', said pre-cursor B' is gelled or coagulated by said reagent.

--169. A method according to claim 168 in which said pre-cursor B' is adapted to undergo gelling or coagulation by the action of an enzyme and an enzyme is incorporated in said pre-cursor A'.

--170. A method according to claim 169 in which pre-cursor B' comprises a protein and said enzyme is a protease.

--171. An apparatus suitable for carrying out a process according to claim 149, comprising an extrusion die having channels for flow therethrough of at least two different relatively soft extrudable materials, said channels ending in orifices for exit in generally one direction of said materials from the channels, said channels being separated from one another in a direction generally transverse to said one direction, dividing members capable of moving in said generally transverse direction across the orifices to divide the flows into segments arranged in at least two adjacent rows extending generally in said one direction, and means for combining said rows of segments into a unitary product, and comprising further means for subjecting said product to conditions to convert at least one of the materials in the product from its relatively soft extrudable state to a relatively hard solid state.

--172. Apparatus suitable for carrying out the process of claim 161, comprising an extrusion die having channels terminating in exit orifices through which at least two different extrudable materials may flow, said orifices being arranged generally in a row and separated from one another generally in the direction of said row, means for causing the materials to pass through the channels and out of said orifices, dividing members which are capable of intermittent movement relative to said orifices in generally said same direction across the orifices to divide the flows of materials therethrough, and means for controlling the movement of the dividing members and said means for causing the materials to pass through the channels and out of said orifices so that relative movement of the dividing members with respect to said orifices takes place intermittently and said materials are passed out of said orifices while relative movement between the dividing members and the orifices is stopped.

--173. Apparatus as in claim 172 wherein said means for causing said material to pass through said channels and out of the orifices thereof comprises a pressure member for each channel operable intermittently to exert and release extrusion pressure upon the material in such channel.

--174. Apparatus as in claim 172 wherein said channels have entrance openings for introduction of the respective materials therein and further comprising reservoirs for the respective materials in communication with said entrance openings to deliver the materials therefrom to said openings and non-return valves

between said entrance openings and said reservoirs to prevent return flow of materials to said reservoirs when said pressure members exert extrusion pressure upon the materials in said channels while allowing flow from the reservoirs to said openings when said extrusion pressure is released.

175. Apparatus as in claim 172 wherein said means for controlling the driving of said materials through said channels and out of the orifices thereof comprises valve means associated with each channel orifice and operable to alternatively block and open said orifices for passage of said materials therethrough.

AMENDED VERSION OF ORIGINAL CLAIMS FOR EXAMINER'S INFORMATION

"1. A three-dimensional food product, elongated in at least [one dimension (] the z-dimension [)] and consisting of at least two components A and B which have been coextruded to become interspersed with each other, in which [one or more] a plurality of cells of component[s] A are surrounded at least in the xz plane by at least one [or more] component[s] B which forms cell walls surrounding the A component, wherein [characterized in that] [the or each] said B component is a solid (including a viscoelastic solid) at 20° C, the cells of component[s] A are arranged in at least two mutually distinct rows extending generally in the z direction, each said row of cells being separated from [the] each adjacent row by a generally continuous [(] in the z direction [)]

boundary cell wall of said B component, and either a) component A is a fluid having no compressional yield point [(being a fluid)] at 20° C or is a solid having plastic, pseudoplastic or viscoelastic consistency at 20° C and [having] a compressional yield point (YP_{B20}) at 20° C which is less than 0.5 x the compressional yield point of B at 20° C (YP_{B20}), or b) component A [being] is an expanded material containing at least 50% by volume gas.

"2. A product according to claim 1 having two generally opposite xz faces and in which each cell of component A extends in a generally [Y] y direction substantially from a position at least [or] adjacent to one xz face of the food product to a position at [or] least adjacent to the other xz face.

"3. A product according to claim 1 in which there are two different B components B_1 and B_2 and the boundary cell wall is formed of [a] said first component B_1 and the product has bridging cells walls branching from said boundary cell wells and extending at least part way in a generally x direction towards the adjacent boundary cell wall, the bridging cell walls being form at least in part of component B_2 [being different from B_1].

Cancel claim 4 and add the following new claim.

--106. A product according to claim 3 in which the components B_1 and B_2 have different yield points at 20° C.--

"5. A product according to claim 3 [or claim 4] in which the yield point of component B_1 at 20° C [,] ($YP_{B1(20)}$) is in the range of 0.1 to 0.5 of the yield point of B_2 at 20° C ($YP_{BP(20)}$).

"6. A product according to claim 1 [in] which has two generally opposite xz faces and each of the cells of component A extends part way between [the] said two xz faces [and in which] with at least two [or more] of said cells [span] spanning the distance between the two xz faces, all of the cells being [and are] separated from one another in the y-direction, and [in which there are] B components are arranged between adjacent cells of component A [which] and are separated from one another generally in the y direction [and forming] to form cell walls around each component A cell, so that the A component cells are substantially enveloped by cell walls of component B.

"7. A product according to claim 6 [and claim 4] having two different B components B_1 and B_2 in which the B component[s] between adjacent cells of the A component separated in the y-direction comprises component B_1.

"8. A product according to claim 1 in which [the B component is formed of a single component and in which] there are bridging cell walls branching from said boundary cell walls separating adjacent rows of A component cells and extending at least part way in a generally x direction toward an [the] adjacent boundary cell wall and [around each] between cells of A component in said rows, and said boundary cell walls and said bridging cell walls are formed of the same B component.

"9. A product according to claim 1, characterized in that any attenuation in the thickness of said [if the] bridging cell walls [that is walls other than the boundary cell are attenuated] in the

vicinity of [the] <u>a</u> boundary cell wall <u>has a</u> [the] local thickness [the attenuated wall is] generally not any thinner than 1/15 of the thickest portion [of said wall] <u>thereof</u>.

"10. A product according to claim 8 [<u>characterized in that</u> (original emphasis)] <u>in which</u> [the] said boundary walls of B-component extend in waved or zig-zagging manner about a plane extending in the zy plane.

"11. A product according to [any of] claim <u>1</u> [s 5 - 10 in] which <u>has bridging cell walls formed of a component B branching from said boundary cell walls and extending at least part way in a generally x direction toward an adjacent boundary cell wall and</u> the bridging cell walls which branch off from the boundary cell walls, considered in a yz plane, branch off substantially perpendicularly to the boundary cell wall at the branching point<u>s thereof</u>.

"12. A product according to [any preceding] claim <u>2</u> which further comprises [edge] <u>surface</u> boundary walls of <u>a component</u> B extending substantially continuously generally [in the z-direction along or] <u>at least</u> adjacent to each [yz] <u>xz</u> face <u>there</u>of [the product].

"13. A product according to claim 1 in which each boundary cell wall <u>separating adjacent rows of cells of said component A</u> is substantially planar [, lying generally in a yz plane].

"14. A product according to [any preceding] claim <u>1</u> in which the cross section of <u>said</u> cells of <u>component</u> A in the xz plane has an average dimension in the z-direction in the range of 0.5 to 10 mm[, preferably in the range of 1 - 5 mm].

"15. A product according to [any preceding] claim 1 in which the average cross-sectional area of said cells of component A in the xz plane is in the range of 0,5 - 100 mm^2 [, preferably 1 - 25 mm^2].

"16. A product according to any preceding claim in which the average [row] separation between adjacent rows of said cells of said component A is in the range 1 - 25 mm.

"17. A product according to claim 16 in which the boundary cell walls of said component B separating adjacent rows of said cells of component A have a minimum thickness in the x direction in the range 5 - 50% of the average [row] separation between adjacent rows [, preferably at least 10%].

"18. A product according to [any preceding] claim 11 in which the bridging cell walls [(being cell walls between cells of A other than boundary cell walls)] have a minimum thickness of 0.1 mm [, preferably a minimum thickness of 0.5 mm].

"19. A product according to [any preceding] claim 1 [, characterised in that] wherein component A in the final form of the product at 20° C is fluid.

"20. A product according to [any of] claim[s] 1 [- 18 , characterised in that] wherein component A in the final form of the product at 20° C is a plastic, pseudoplastic or viscoelastic material [cell] having a compressional yield point, YP_A lower than 1000 g cm^{-2} [and preferably lower than 500 g cm^{-2}].

"21. A product according to claim 20 [, characterised in that] wherein component A [consists of] comprises a blend of [on

one hand] solid particles selected from the group consisting of short fibres, nut- grain- or shell-pieces, film-pieces or flakes, [and on the other hand] with a water based solution or gel.

"22. A product according to claim 20 [, characterised in that] wherein component A [consist of] comprises a blend of [on one hand] solid particles selected from the group consisting of short fibres, nut-, grain-, or shell-pieces, film-pieces or flakes [, and on the other hand] with an oil.

"23. A product according to [any preceding] claim 1 [, characterised in that] wherein component B is in the form of a gel.

"24. A product according to [any preceding] claim 1 in which component B [, optionally] including a component B reinforced with solid particles selected from the group consisting of short fibres, or grain-, shell- or film-pieces or flakes, has a yield point YP_B, of at least 200 g cm^2[, preferably in the range of 500 to 80,000 g cm^2, and more preferably no more than 60,000 g cm^2].

"25. A product according to [any preceding] claim 1 [, characterised in that] wherein component B is [based on] comprised of fat, oil or wax with flavoring additives [additions for the taste, preferably it consists of chocolate].

"26. A product according to [any of] claim [s] 1 [- 24, characterised in that] wherein component B [is based on] comprises protein .

"27. A product according to [any of] claim[s] 1 [- 24, characterised in that] wherein component B is a microporous agglomerate of particles containing water in the pores, [and that

the] said particles [consist] being selected from the group consisting of short fibres or grain-, shell- or film-pieces or flakes [, which particles] and are bonded together by [polymeric] micro-stands of a polymer selected from the group [, e. g.] consisting of coagulated gluten or a natural or synthetic rubber as produced by coagulation of a latex.

"28. A product according [to any of] claim [s] 1 [- 24 [, characterised in that] wherein component B [is or contains] comprises a gel [based on] of a polymer [belonging to] selected from the group consisting of carbohydrates or carbohydrate related compounds.

"29. A product according to claim 1 [, characterised in that] wherein component B comprises a polymer and in the boundary cell walls of said polymer B extending in a generally z direction the molecules thereof are molecularly oriented generally in the [general] z direction.

"30. A product according to claim 1 [, characterised in that] wherein component A is a juice containing dissolved sugar and is [optionally] in form of a flowable soft gel or thick liquid thickened with a thickening agent [and being flowable and that A contains dissolved sugar].

"31. A product according to claim 1 [, characterised in that] wherein component A is a juice [optionally] in the form of a soft gel or a thick liquid thickened with a thickening agent [,] and [that A] contains hydrolysed proteins to [give it] in sufficient amount to impart taste and nutritional value [comparable to meat].

"32. A product according to claim 1 [, characterised in that] wherein component A contains a pulp of [short] subdivided protein fibres or [pieces of protein] film.

"33. A product according to claim 1 [, characterised in that] wherein component A is a cultured milk product.

"34. A product according to claim 1 [, characterised in that] wherein component A is marzipan.

"35. A product according to claim 1 [, characterised in that] wherein component A [is] comprises a meat paste [based on meat].

"36. A product according to claim 1 [. characterised in that] wherein the A component contains gas dispersed therethrough.

"37. A [bread or cake] product according to claim 36 which is a bread or cake and component [, characterised in that] A [is based on] comprises expanded and baked starch and B [is based on] comprises protein.

"38. A product according to claim 36 [characterised in that] wherein component B comprises cheese.

"39, A product according to claim 1 [, characterised by containing] wherein component A has two different [A-] components, A1 and A2.

"40. A product according to claim 39 in which component A1 [is] comprises a waterbased solution [or contains such solution] or gel [as] forming a matrix for solid particles, and A2 [is fat- or oil-based or contains] comprises fat or oil [as] forming a matrix for solid particles.

"41. A food product which is a three dimensional solid [(including viscoelastic solid) food product] at 20° C and is elongated in at least [one dimension (] the z-dimension [)] and consists [ing] of at least two components A and B which have [having] different visual appearances and [which] have been coextruded to [become interspersed with one another in which there are] intersperse segments of A and segments of B, [characterised in that the or] wherein each B component is a solid [(including a viscoelastic solid)] at 20° C and [the or] each A component is a solid [(including a viscoelastic solid)] at 20° C [)], the segments of component A are arranged in at least two mutually distinct rows extending generally in the z-direction, and [in which] the rows of segments of component A and interspersed segments of component B are visible at at least one surface of the product extending generally in a [general] xz plane.

"42. A product according to claim 41 in which [the thickness of] the segments of component A and segments of component B are attenuated in their minimum thickness adjacent their ends [close to the border between two rows is] as compared to their thickness at points intermediate their ends [distant from the boundary cell walls (where the thickness at any point is the shortest distance across the segment at that point)] and in which the segments are dragged out during their coextrusion so as to form an acute angle of less than about 45° with the z-direction in the xz plane.

"43. A product according to claim 41 [or 42] in which component A and component B are selected from the group consisting of [consist of one of] the following combinations:

a. dark [er] chocolate/ [ligther] light chocolate

b. chocolate/marzipan

c. chocolate/caramel

d. two differently coloured edible gums or fruit gels.

"44. A method of manufacturing by coextrusion of a plurality of extrudable edible components in an extrusion die a solid food product in which the components are extruded in a z-direction from the extrusion die and exit therefrom, and in which at least one extrudable component A' is formed into a flow through a channel and an extrudable component B' is formed in a flow through a channel, the flow of B' being in generally an x direction transverse to said z direction [x-wise] adjacent the flow of A', [x being transverse to z], in which [the flows of A' and B' exit from the channels through exits after which,] after exiting from said die, the flows of A' and B' are regularly divided [in a] generally in said x-direction by a dividing member to form at least two rows of flows of A' and B' separated in the x-direction, in each of which rows the flows of A' and B' are segmented in the z direction [and in which in each said row] with a segment of flow of B' [is] being joined upstream and downstream to each segment of flow of A', whereby B' segments are interposed between adjacent A' segments in the z direction and in which adjacent rows are joined to one another along their yz faces, [each row of segmented flows of A'

forming a row of cells of A' extending generally in the z-direction] and wherein after the joining of the segmental flows B' is transformed to a normally solid material [(including a viscoelastic solid B,, or, if B' is already viscoelastic, is transformed to a material B] having a compressional yield point which is at least twice that of B'.

"45. A method according to claim 44 in which after the segments of flows are joined, [said joining] the material A' is expanded to at least twice [the] its original volume [of A'], or [, if] material A' is treated to reduce its yield point, if material A' is solid, or its apparent viscosity, if material A' is liquid, by at least one-half [is plastic, pseudoplastic or viscoelastic is transformed to a material A having a lower yield point than the yield point of A' by a factor of at least 2 or to a fluid, or, where A' is a fluid, is transformed to a fluid A having an apparent viscosity less than half that of A'].

"46. A method according to claim 44 [or 45], [characterised in that] wherein the extrusion is carried out at an elevated temperature and material B' is treated [the transformation of B' takes place] by cooling.

"47. A method according to claim 44 [or claim 45] wherein [characterized in that the said transformation of] material B' [takes place by] is treated for form a coagulate [ion] or gel [for formation].

"48. A method according to claim 47 [, characterised in that] wherein material B' is heated to form the coagulate [ion] or gel [formation is established by heating].

"49. A method according to claim 47 [, characterised in that prior to the extrusion process] wherein material B' normally has [is formed as an extrudable material by disruption of] a continuous, firm gel structure and prior to its coextrusion is converted into extrudable form by disruption to a finely divided condition, and after the end of the coextrusion, material B' is treated to reestablish its [the] continuous firm structure [of this gel is reestablished by heating followed by cooling, or, if the gel is adequately thixotropic, spontaneously or upon storage].

"50. A method according to claim 47 [, characterised in that] wherein material B' is treated by chemical reaction to form the coagulate [ation] or gel [formation is carried out by chemical reaction].

"51. A method according to claim 50 [, characterised in that when the gel formation can be made sufficiently slow,] wherein a [the] gelling reagent or coagulant is incorporated into material B' prior to the extrusion process and the rate of gelation or coagulation is retarded to delay gelation or coagulation until after the completion of said joining of said flows.

"52. A method according to claim 51 in which [the] said reagent or coagulant is incorporated into solid particles suspended in material B'.

"53. A method according to claim 51 in which material B' is adapted to undergo gel formation or coagulation by enzymatic action and the gel formation or coagulation is carried out by means of an enzyme [atic, or instance involving a protease such as rennin to break down and coagulate milk protein].

"54. A method according to claim 47 [, characterised in that the] wherein material B' is adapted to undergo gel formation or coagulation by action of a reactant and [is established by including a] said reactant is incorporated in the material A', [this reactant] thereby gradually migrating into material B' [component] when [the components] materials A' and B' are brought together in the coextrusion die.

Cancel claim 55 - 63.

"64. A method according to [any of] claim [s] 44 [- 63] in which both material A' [is formed into at least two flows separated from one another in the x direction and in which] and material B' [is] are each formed into at least two flows separated from one another in the x direction and in which flows of material B' are partially interposed between [part of] adjacent flows of material A'.

"65. A method of coextruding at least two extrudable materials A' and B' in an extrusion die [in] which comprises the steps of supplying at least one [extrudable component] material A' [is supplied] from a reservoir therefor [A'] and advancing the same by extrusion pressure as [is formed into] a flow through one [an] extrusion channel and out of [to] an exit from the channel end [for

A']; [and] supplying at least one [extrudable] material B' [is supplied] from a reservoir therefor [B'] and advancing the same by extrusion pressure as [is formed into] a narrow flow through [an] a separate extrusion channel [to] and out of [the] an exit [for B'] from the channel end; [in which the] dividing each of the flows of materials A' and B' [are each divided] not prior to [at or after] the respective channel exits into [form] segments of the respective extrudates [each] by a dividing member therefor, each said dividing member moving [which moves] relative to the corresponding channel [extruder] exit from a first position [in which] on one side of the respective channel exit, across the channel exit to a second position [the dividing member has traversed the entire] on the opposite side of such channel exit[,] ; and controlling the flows of both materials A' and B' out of the extrusion channels [are] exits to cause said flows to be intermittent in nature in synchronism with the movement of said dividing members [, controlled either by providing a ram close to or within each channel which drives the flow intermittently or by opening a valve between the inlet to the respective extrusion channel and the reservoir from which the component is supplied under pressure, the movement of the ram or the opening of the valve as the case may be, being co-ordinated with the relative movement between the dividing members and the channel exits such that material is driven through the exits while the relative movement is stopped in said first and second positions, but is not driven through the exits during the change of positions].

Add the following new claims:

--107. The method of claim 65 wherein said flows of said materials A' and B' are controlled to cause the respective materials to flow from the corresponding channel exits when said dividing members are in said first and second positions but not when said dividing members are moving across said channel exits.

--108. The method of claim 65 in which said flows of said materials A' and B' are controlled to take place intermittently by periodically applying and releasing said extrusion pressure to the respective materials in the corresponding channels.--

--109. The method of claim 65 in which said flows of said materials A' and B' are controlled to take place intermittently by periodically blocking and opening the channel exits to prevent said materials from exiting therefrom.

Cancel claims 66 and 67.

"68. A method according to [any of] claim [s] 65 including the additional step of joining together the segments of said materials A' and B' after their formation by said dividing member so that segments of material A' alternate with segments of material B' [- 67 in which there is a segment of flow of B' joined both downstream and upstream to each segment of flow A' is joined to].

"69. A method according to claim 68 in which the relative movement of said dividing members with respect to said channel exits creates a plurality of adjacent [at least two x-wise adjacent z-wise extending] rows of segments of material A' and segments of

material B' [are] joined to the segments of material A' in said rows [one another along their zy faces].

"70. A method according to claim 44 [or 69 in] which comprises the further step of collecting the rows of segments of materials A' and B' after they are joined, in a collection chamber in the form of a sheet [and in which the sheet that is formed in preferably taken off on a conveyor].

Cancel claims 71 - 98.

"99. A method of manufacturing by coextrusion in sheet, ribbon or filament form of a food product which is normally solid at 20° C and is [in sheet, ribbon or filament form, which product consisting] comprised of at least two components A and B in segment form, wherein segments of component B [being] are in contact with segments of component A, [in] which comprises extruding flows of an extrudable component A pre-cursor A' and of an extrudable component B pre-cursor B' [are coextruded] from separate orifices of an extrusion die, sub-dividing each of said flows into segments and combining said sub-divided flows in rows with the segments of pre-cursor B' generally alternating with segments of pre-cursor A' and, after extrusion, converting said pre-cursor B' [is transformed] to a solid material [(including viscoelastic solid)] B, or, if B' is already viscoelastic, is transformed to a material B having a compressional yield point which is at least twice that of B'], in which extrudable pre-cursor B' is adapted to be rendered normally solid by coagulation or gel formation and [is transformed by coagulation or gel formation initiated by] a coagulant or gelling

reagent is incorporated in pre-cursor A' whereby when said segments of pre-cursor B' are in contact with segments of pre-cursor A', said pre-cursor B' is gelled or coagulated by said reagent.

"100. A method according to claim [97] 99 in which said pre-cursor B' is adapted to undergo gelling or coagulation by the action of an enzyme and [the coagulant or gelling reagent is] an enzyme [, preferably a protease, for instance rennin] is incorporated in said pre-cursor A'.

"101. A method according to claim [98] 100 in which pre-cursor B' comprises a protein [, for instance milk protein] and said enzyme is a protease.

"102. An apparatus suitable for carrying out a process according to claim 44, comprising an extrusion die having channels for flow therethrough of at least two different relatively soft extrudable materials [and], said channels ending in orifices for exit in [a] generally [z] one direction of said materials from the channels, said channels being [which are] separated from one another in [the x] a direction generally transverse to said one direction, [further comprising] dividing members capable of [producing at least two rows of flows of extrudate extruded materials by] moving in said generally transverse direction across the orifices to divide the flows [in a generally x direction] into segments arranged in at least two adjacent rows extending generally in said one direction, and means for combining said rows of segments into a unitary product, and comprising further means for subjecting [the] said product to conditions to [transform

components of] convert at least one of the materials in the product [form a] from its relatively soft extrudable state [material] to a relatively hard solid state [material].

"103. Apparatus suitable for carrying out [a] the process [according to] of claim 65, comprising an extrusion die having channels terminating in exit orifices through which at least two different extrudable materials may flow, said orifices being arranged generally in a row and separated from one another generally in the direction of said row, means for [driving] causing the materials to pass through the channels and out of said orifices [separated from one another in the generally x direction], [and having] dividing members which are capable of [moving] intermittent movement relative to said orifices in generally said same direction across the orifices to divide the flows of [extrudate] materials therethrough [in a generally x direction], [in which] and means for controlling the movement of the dividing members and said means for [the driving of] causing the materials to pass through the channels and out of said orifices [are controlled] so that relative movement of the dividing members with respect to said orifices takes place intermittently and said materials [is diriven] are passed out of said [through the] orifices while relative movement between the dividing members and the orifices is stopped.

Cancel claim 104 and 105.

Add the following new claims:

--110. Apparatus as in claim 103 wherein said means for causing said material to pass through said channels and out of the

orifices thereof comprises a pressure member for each channel operable intermittently to exert and release extrusion pressure upon the material in such channel.

--111. Apparatus as in claim 103 wherein said channels have entrance openings for introduction of the respective materials therein and further comprising reservoirs for the respective materials in communication with said entrance openings to deliver the materials therefrom to said openings and non-return valves between said entrance openings and said reservoirs to prevent return flow of materials to said reservoirs when said pressure members exert extrusion pressure upon the materials in said channels while allowing flow from the reservoirs to said openings when said extrusion pressure is released.

--112. Apparatus as in claim 103 wherein said means for controlling the passing of said materials through said channels and out of the orifices thereof comprises valve means associated with each channel orifice and operable to alternately block and open said orifices for passage of said materials therethrough.--

REMARKS

The original claims have been extensively amended to 1) eliminate instances of multiple dependency, 2) modify the original claims from their initial European format to more closely comply with U. S. claim practice in respects far too numerous to catalogue and 3) clarify or improve the original language where possible.

In the final form of the claim schedule, there are **five independent** claims: 106, 145, 149, 161, and 168. Claims 102 and 103 are apparatus claims referring to process claims and are considered dependent claims. See MPEP 608.01 (n) III, last paragraph. Of the 105 original claims, 42 have been canceled; 7 new claims have been added. Thus, the total number of claims now standing in the case is 70.

There apparently has been some confusion as to the scope of preliminary examination by the International Bureau and efforts to clarify this matter have so far been of little avail. Under the circumstances, Early consideration of the application and its claims in their amended form would be appreciated and is requested.

Respectfully submitted,

William J. Daniel
Attorney of Record
Reg. No. 16,585

(703) 527-0068

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FOOD PRODUCT WHICH ARTIFICIALLY HAS BEEN GIVEN A CELL-LIKE STRUCTURE BY COEXTRUSION OF SEVERAL COMPONENTS, AND METHOD AND APPARATUS FOR MANUFACTURING SUCH FOOD PRODUCT

The invention concerns a food product in sheet, ribbon or filament form consisting of at least two components which have been coextruded to become interspersed with each other and form a row-structure, and methods and apparatus for making such product.

In the term "food" product, I intend to include animal food, confectionary and medical products. The inventor's two (expired) patents US-A-4,115,502 and WO-A-4,436,568 disclose such products. The former discloses:

a) strands of a viscous sugar solution, interspersed with strands of dough; and coextruded sheet formed product is subsequently baked - and;

b) strands of highly viscous, dissolved or swollen protein and a viscous sugar solution, caramel and/or dough; the coextruded sheet formed product is subsequently solidified. (see col. 6 line 65 to col. 7 line 5 of this patent).

The other above mentioned patent contains an operative example for making a similar food product namely example 4. Here an alkaline solution of soya protein is interspersedly, side-by-side coextruded with a solution of carboxy-methyl-cellulose to which is added caramel (for sweetening and aroma). To achieve a regular structure the two solutions have the same viscosity.

The coextruded sheet formed product is collected on a conveyor film of polyester (later to be used as wrap for the product) and is solidified by rinsing a solution of NaCl - lactic acid over it. This causes the protein to coagulate.

In each of the above mentioned examples each of the interspersed strands is a continuous strand. In US-A-4,436,568 this clearly appears from the text of the example when the letter is studied in conjunction with the drawing to which it refers. In US-A-4,115,502 the only apparatus/method which is

disclosed for interspersed coextrusion - see fig. 4 and connected description - will always produce continuous strands. EP-A-0653285 and WO-A-9934695 concern different methods of coextruding food components as a multiplicity of layer, one on top of the other, and each patent gives examples of suitable components for such structures.

The food product according to the present invention is characterised as defined in claim 1.

Preferably the defined cellular structure extends generally throughout the product.

Compressional measurements of the resistance to deformation are commonly used in the food industry especially for the characterisation of gels.

However, to the knowledge of the inventor there exists no standardised procedure for such measurements and no specifications of what is "soft" and what is "hard", other than the standardisations and specifications used internally in companies producing food products. Furthermore, as it is well-known, the pressure required for permanent deformation in form of flow or fracture (the "yield point") cannot be indicated as an absolute value, but depends on the time-scale within which the measurements are made and to a lesser extend on the method and apparatus used. For "feel" in the mouth it is generally considered that a time scale of about 0.1 second is relevant, but the inventor has chosen to relate the measurements to a 10-seconds time scale, which is a stricter requirement.

The description in connection with fig. 13 explains the apparatus which the inventor has constructed for measurement of compressional yield point and the procedure followed. For the purpose of this patent specification the minimum pressure which within 10 seconds gives at least 10% compression (in excess of the instant elastic deformation) is considered to be the yield value. However if B is microporous as it may be, the deformations taking place before compacting of the material should be disregarded. The following table which is made in order to corelate subjective feels with objective values indicates typical compressional yield values for misc. common products:

Dessert (e.g. crème caramel).....about 3 g cm^{-2}

Marzipan:....about 400 g cm^{-2}

Hardboiled egg white:...about 900 g cm^{-2}

Emmental cheese:.. about 3 kg cm^{-2}

Apples:...about 3kg cm^{-2}

Carrots:...about 20 kg cm^{-2}

Dark chocolate:...about 50 kg cm^{-2}

Fresh pine wood, in its weakest direction:...about 80kg cm^{-2}

In the present invention, the yield point of B component or each of the B components should normally be no less than 200g cm^{-2} and more preferably not less than 500 g cm^{-2} while it should preferably be no higher then 150 kg cm^{-2}.

Extruded food structures in which distinct particles or phases of one material is randomly distributed in a matrix of another component are known e.g. from CH-A-0538814 (cheese), US-A-4697505 (chip cookies), US-A-3671268 and US-A-22313060 (ice cream), EP-A-0258037 and US-A-4358468 (meat) and EP-A-0775448 (caramel/chocolate). However the well-ordered structure of the present product, obtained by the special features of the method which is described below, enable an improved "taylor-making" of "mouth-feel" and taste.

It is further known to produce an individual encased food item or a single row or filament of encased food items, see e.g. EP-A-0246667, US-A-4,828,780, col. 9 lns. 43-58 and US-A-4,469,475. However, the character of such products are very different from that obtained by the present invention.

A in the final form of the product, at 20°C, may be in a liquid state. Alternatively A may be of plastic or viscoelastic character for instance in the form a soft gel. A liquid or gel may comprise dispersed solids such as short fibres, nut, grain or shell-pieces, pieces of film or flake in a liquid or gel continuous phase, for instance aqueous solution or gel, or an oil. A liquid A may comprise a dissolved thickener. Another embodiment of A comprises an expanded material, such as formed by the presence of a raising agent in the

extruded material. The B component or B components should preferably belong to one of the following three groups of materials:

a) firm gels, optionally with inclusion of fine preformed solid particles,

b) bonded-together preformed solid particles,

c) fat-based materials like chocolate.

Preferably the compressional yield point YP_{B20} of B at 20°C is at least 500 g cm^{-2}, for instance in the range 500 g cm^{-2} to 80 kg cm^{-2}, generally less than 60 kg cm^{-2}.

The product A preferably is fluid, or is a gel or plastic or plastic or pseudo-plastic material which has a compressional yield point YP_{A20} at 20°C which is less than 1000 g cm^{-2} and more preferably less than 500 cm^{-2}.

In the present invention a gel is understood to be a three dimensional network formed of polymeric components, whether linked by chemical bonds or crystallites, or some other kind of junction, swollen by a liquid, which is generally self supporting, for instance when placed on a flat surface, rather than being fluid.

It is immediately understandable that the invention provides a new concept for achieving a food product which on the whole has a solid and mechanically stable consistency and nevertheless is pleasantly chewable and in all respects makes a natural feel in the mouth, be it a substitute of meat, a filled chocolate, another type of confectionery, a snack, snack-masked medicine, or a completely new combination of food ingredients. While A e.g. can be a continuous soft gel of plastic character within each platelet or lump, it is essential that B also can be a continuous gel, but in this case a firm gel.

Later in this specification the possible compositions of A and B will be further described.

Specific examples of the nature of components A and B are given in claims 25 to 38.

The short reinforcement fibres or grain-, shell or film-pieces or flakes in some of those claims in relation to components A and B are preformed, and are preferably but not necessarily digestible, or of value for the digestion e.g. short protein fibres. An important example of applicable shell-pieces (or husks) is

bran. They may contain absorbed aroma substances or the protein used for the fibres or film-pieces may have been brought to react with carbohydrate to form a caramel related compound.

As it is understood from the above, B forms “cell-walls” and A the “cell-contents”. Typically the biggest average dimension of the cell is between about 1-30mm, and the smallest dimension about 0,1-3 mm. Due to the characteristics of the extrusion process, the cells are almost always of a curved shape, although exaggeration of such shape can and preferably should be avoided. The indication of the biggest dimension refers to measurements along the curved surface of the cell.

The cross section of cells of A in the xz plane generally has an average dimension in the z direction in the range 0.5 to 10 mm, preferably in the range 1 to 5 mm. Generally the cells of A have an average cross sectional area in the xz plane in the 0.5 to 100 mm^2, preferably in the range 1 to 25 mm^2.

In the majority of the cells the thickness of the cell wall should preferably not at any place be smaller than 2% of the average thickness of the lump or platelet which is contained in the respective cell, since otherwise the mechanical stability may be insufficient. More preferably it should not be smaller than 5% and still more preferably 10% of the said average thickness.

In the invention the average row separation is preferably in the range 1 to 25 mm, more preferably 3 to 15 mm for instance 5 to 10 mm. Generally the boundary cell walls have a minimum thickness in the x direction in the range 5 to 50% of the average row separation, preferably more than 10 %.

The bridging cell walls, that is cell walls of B, between cells of A other than boundary cell walls, have a minimum thickness of 0.1 mm, preferably a minimum thickness of 0.5mm.

On the other hand, to give the product a suitable consistency, the average wall thickness in the majority of the cells should normally not exceed the average thickness of the cell of A.

In most cases when A is fluid, the nesting of A in B should preferably be a full encasement in three dimensions at least for the majority of the platelets or lumps. This is the more advantageous the more fluid A is.

The most advantageous row-formed cell structure is the composite structure with boundary cell-walls and, branching off herefrom bridging cells-walls, in a generally x-wards direction, for instance as stated in claim 3 and illustrated in fig. 1a. In this drawing there are shown two B-components B1 and B2 (and the reasons for using 2 B-components as shown will be given below) but the drawing must be understood so that B1 and B2 can be one and the same component.

The coextrusion method for producing this structure may cause some attenuation of A as well as B close to the locations of cell wall branching, see fig. 3. By appropriate choices of the conditions during the extrusion such attenuations should preferably be limited so that the thicknesses of a branch and a boundary cell-wall both measured at the location of branching-off, should generally not be any smaller than 1/15 of the biggest thickness of the branch. More preferably not smaller than 1/10 and still more preferably not smaller than 1/5 of said biggest thickness.

To facilitate chewing of the food product and make it feel most natural in the mouth, B may be selected to have stronger cohesion than adhesion to A. This effect can be achieved by addition to B of a substance which promotes the slip, e.g. a fat to a hydrophilic B-substance.

Contrarily there may be a need to strengthen the bonding between A and B, and this can be achieved by providing that the boundary cell walls of B extend in a waved or zig-zagging manner about a generally zy plane.

Within the product having boundary cell walls of B, each cell of A may bridge the whole way between the boundary cell-walls. This is shown in fig. 1a and will in many cases give the best consistency of the product. However, the cells of A can also depending on the method of manufacture and further dealt with later be included as shown in fig. 2, or in a less ordered manner but still exhibiting a row structure.

The additional cell-wall stated in claims 6 and 8 serve to perfect the nesting of A in B, and are illustrated in fig. 1b, c and d.

A and B may in fact each comprise more than one component. Very advantageous example of B comprising 2 components B1 and B2 (joined

adhesively with each other) are stated in claims 3 and 4 and illustrated in figures 1a and b, 4a and b, preferably exhibiting a compressional yield point which is at least double that of B1. More preferably the yield point YP_{B120} of B_1 at 20°C is in the range 0.1 to 0.5 of the yield point YP_{B220} of the B_2 at 20°C. Thus B2 may e.g. be tougher than B1 (in the final state of the product) depending on the method of manufacture and further dealt with later so that B1 easily is disrupted by the chewing to release the (tasty) A-, while the consumption of B2 requires more chewing work - which is felt as a good combination. Furthermore when B2' is less deformable than B1 in the state it has during and immediately after the dividing in the coextrusion process, B2' helps to achieve the most regular cell structure. (In this specification the extrudable material used to make A of the final product is referred to as A' during the process; likewise extrudable B' forms B after processing, B1' forms B1, B2' forms B2 etc.

These aspects are dealt with in connection with method claims

In one embodiment B1 is twisted around cells of A. The twisting can take place by the flow alone when the extrusive conditions for this are selected so that the segments of A' rotate. This is further explained in connection with fig 7a, b and c.

The boundary cell walls of B extending generally z-direction may be molecularly oriented in the generally z-direction. This is achieved by using suitable extrusion methods and apparatus. The orientation helps to make the product feel like meat when it is chewed.

The incorporation of a pulp of short protein fibres or pieces of protein film in A, has a similar purpose as the orientation and also purposes connected with the taste and nutritional value. Component A alternatively can consist of other short fibres or film pieces or of nut-, grain-, or shell-pieces, or flakes. Also in this connection, grain can be very suitable. When A is a cultured milk product, it can either be given sweetness and aromatic taste for use in the product as confectionary or dessert, or be spiced like “chutney” for products used in a first course or main course.

The incorporation of gas in the A cells is normally achieved by use of an expansion agent like the expansion of dough in breadmaking, or the expansion of vegetable protein with evaporating water in the conventional extrusion of meat substitute.

In bread or cake products, the B-component (cell-walls) based on protein serves to give the product a good mechanically stability even when the contents of the cells are very fragile (second grade flour or high contents of grain) or the product is very expanded. The use of cheese for the cell-walls is mechanically suitable and provides an interesting taste combination.

In an embodiment B is a microporous agglomerate of particles containing water in the pores, and that the said particles consist of short fibres or grain-, shell- or film-pieces or flakes, which particles are bonded together by polymeric micro-strands, e.g. consisting of coagulated gluten or a natural or synthetic rubber as produced by coagulation of a latex.

In another embodiment, which may be a meat substitute, A comprises two separate components:

A1) a semi-solid fat or oil based component containing the fat/oil soluble ingredients, and

A2) a juice containing the water soluble taste ingredients,

B) a component suitable for chewing.

In the first independent method claim, a method is defined which is suitable for producing the new product (though not restricted thereto). In the method, cells of A are formed by extruding an extrudable material A' and coextruding an extrudable component B' which forms D and in the method flows of A' and B' are adjacent to one another in a direction transverse to z, the flows of A' and B' being regularly divided generally transverse to the direction of flow by a dividing member to form flows of A' and B' segmented in the z direction, a segment of flow of B' being joined upstream and downstream to each segment of flow of A, the process being characterised in that B' is transformed to a harder material B after extrusion, the yield point being at least 20 g cm^{-2}.

In the first aspect of the method of the invention, after exit from the extruder B' as modelled around A' segments so as to surround the A' segments

substantially completely in an xz plane. Furthermore, preferably A' is formed into at least two flows, and two rows of segments of A separated by a boundary cell wall of B are formed to form the novel product.

The claims define further a second method aspect of the invention. This aspect is defined in the second independent method claim. Preferably several flows of components A' are formed interposed with flows of B'. The dividing members reciprocate or rotate relatives to the extruder exits to form segmental streams whilst modelling B' around A'.

The second method aspect of the invention may be used to extrude food products or may alternatively be useful for extruding other extrudable materials such as thermoplastic plastics materials. When the method is used for extruding food, preferably B' is transformed after extrusion to a material having a higher yield point as the first method aspect of the invention.

There are several ways of providing relative movement between the dividing member(s) and extrusion exits.

In one preferred method of the invention, the relative movement is provided by fixing the extruder components including the channels and exits, and moving the dividing members. For instance, the x direction may be arranged substantially vertically, with one or more flows of A' having flows of B' above and below, and to provide the extruder exits on a circular cylindrical surface having a substantially horizontal access. The dividing member is pivoted around the said horizontal access so that the dividing members reciprocate on the said circular cylindrical surface. One extruder suitable for putting this embodiment into effect is illustrated in fig. 11a and b.

Another way of carryingout the second the second aspect of the method invention, is for direction x to be substantially horizontal, and for flows of A' and B' to be arranged in a horizontal array, with flows of B' between flows of A', and with the dividing members reciprocating or rotating in a generally horizontal direction.

It is to be understood that the direction of extrusion of the component A' and B' is in a generally z direction, that is it should have a component of movement in the z direction. However it may additionally have a component of

movement in the x or y direction. Furthermore components A' and B' may be provided with movement in a direction having components of movement in the same or different x or y directions.

Whilst the invention has been described, and it described in the following description as being from a conventional flat-die, with components and directions defined by reference to an orthogonal coordinate system based on the x, y and z axes, the dies may alternatively be circular, in which case the coordinates could alternatively be replaced by r, θ and z. The direction of extrusion, that is of flow of A' and B' from the extruder exits may be in the z direction, the r direction (either inwardly outwardly directed) or substantially the θ direction. Where the extrusion is in a generally z direction or generally r direction, the dividing members preferably rotate or reciprocate in the θ direction. Where the material exits from the extruder in a r direction or θ direction it may alternatively be possible to reciprocate the dividing members in a z direction. Apparatus adapted from the inventor's earlier apparatus described in US-A-3,511,743 or US 4,294,638, both based on circular dies, could be utilised in such embodiments.

This type of coextrusion belongs to a "family" for which the inventor in the past introduced the name "lamellar extrusion". This signifies a coextrusion method by which two or more extrudable components first are interspersed with each other in a sheet-like array of flows which then are mechanically sheared out by means of transversely moved dieparts in a way that produces a sheet of thin lamellae - continuous or discontinuous - which are positioned at an angle to the main surfaces of the sheet.

To the knowledge of the inventor the only published inventions within this "family" are contained in French patent no. 1,573,188 issued to Dow Chemical Limited., and those patented by the inventor of the present invention, comprising the two U.S. patents mentioned in the introduction to this specification (and counterparts in other countries), and further, referring to U.S. patent numbers, the following: 3,505,162; 3,511,742; 3,553,069; 3,565,744; 3,673,291; 3,677,873; 3,690,982; 3,788,922; 4,143,195; 4,294,638; 4,422,837; and 4,465,724.

Only the two patents mentioned in the introduction to this specification by the present inventor disclose the use of lamellar extrusion for manufacture of food products, and as mentioned the components are not formed in to segments according to these disclosures. The disclosures in the other patents are limited to synthetic polymers with a view to the manufacture of textiles or textile-like materials, and in a few cases reinforced board materials. The modelling of one component around segments of another component is not disclosed, neither is there disclosed any formation in these synthetic products of a cell structure comparable to the cell structure dealt with in the present invention.

EP-A-653285, which has been mentioned earlier in this specification, uses the interspersion method disclosed in the above mentioned US-A-3,511,742 and in several of the other above mentioned patent specifications, to produce a multi-layered food product in sheet or plate form. The layers are not "lamellae" but are parallel to the main surfaces of the sheet/plate and are not broken up into segments.

For establishment of the cell structure according to the invention it is essential that the segments of B become modelled around the segments of A. One way for achieving the modelling is by requiring that the B' has a lower viscosity, and yield point if any, under the process conditions which is significantly lower than those of A'. Preferably the viscosity and or yield point is less than 0.5 the viscosity or yield point, as the case may be, of A under the process conditions. A further improvement is achieved by minimising adhesion of the A' to the dividing members by incorporating an oil or fat in A'.

An alternative or supplementary way of achieving the modelling of B' around A' is by merging the flow of A' with a flow of B' on each side (in the x direction) prior to the extruder exit. This embodiment will be described in more detail below.

At the time of dividing, A' should preferably not be liquid, but can be plastic, pseudoplastic, gelformed, can be a dry powder or in other way a particulate material. In each case it means that, very generally speaking, a

certain minimum value of shear force is needed to cause permanent deformation under the conditions in the die.

B', on the other hand, (or B1 if there are two B-components in the arrangement shown in fig. 1a and 4a) should at this stage of the process be of a fluid to plastic consistency and generally exhibit a lower resistance to permanent deformation. It should preferably have plastic consistency in order to make the extruded product self-supporting as it leaves the die.

The ways of interspersing the components with each other and to carry out the movements which cause the dividing of the flows of A' and B', amy be based on the patents on lamellar extrusion, which are listed above.

As well as being a relative recprocation between the channels and orifices on the one hand and the dividing members on the other hand, it may be advantageous to provide for the relative reciprocation or rotation between the row of dividing members and the exit chamber,(which is known *per se* from the mentioned patents) serves to arrange the filaments in the final product in a generally transverse direction (if this is wanted) and/or to increase the bonding between the filaments.

In order to optimise the shaping of the segments in the dividing process this should preferably take place by shear between on one side the internal orifices through which the mutually interposed narrow flows are extruded, and on the other side the row of dividing members, and furthermore best by cutting action (see claims 82 and 83). The different ways of realising the cutting are specified in claims 84 to 86. Examples of the shape and positioning of the knives for this action are shown in figures 6a and 9. By means of the severing action and/or the "microsawing" specified in claim 86 it is possible to form very fine slices of the components even when these contain pulp or fibres.

The dividing of the narrow flow to segments is preferably carried out in rhythmic operations with the dividing members acting as shutters (i.e. being of a width so as to be able to completely shut off the orifices), and furthermore with at least component A' extruded in pulsations such that maximum driving force of the material A' through the channel is imposed while the orifices for A' are open. These features are shown and further explained in connection with

figures 8. The pulsations are preferably produced by a ram for each narrow flow of the component, localised at the entrance to the chamber for the narrow flow - see fig. 8c - and optionally extending into the chamber. It depends on details of the process and the choice of component whether the flow mainly will be caused by the conventional feeding means (e.g. a pump or an extruder) optionally in combination with intermittently operated valves or by the above mentioned rams.

The use of intermittent extrusion in connection with lamellar extrusion is known, with other aims, from the above mentioned U.S. Patent No. 3,788,922 see col. 2, lines 51-64, col. 3, lns 4-13, col. 4, lns. 45-53, example 1 and example 2. This patent discloses the use of shutters to achieve the intermittent extrusion, but does not disclose that the dividing partitions can be used as shutters. Furthermore it discloses the use of a vibrating piston to cause the pulsations, but this is a piston between the extruder and the die instead of (as in the embodiment of the present invention) one ram (piston) for each narrow flow and installed in the die itself.

A very advantageous way of achieving the modelling of B' around the segments of A' is stated in claim 73 and in a preferred embodiment is claim 74. Generally speaking, two generally yz surfaces of each segment of A' are covered mainly by the part of B' which is joined with A' prior to the dividing, and the two xy surfaces of the segment of A' is covered mainly with B' from those internal orifices which carry B'-component alone. This provides improved possibilities for controlling the thickness of the B' layer in contact with the dividing member.

A modification of this embodiment of the method comprises the use of two B'-components B1' and B2'. It is specified in claim 75 and shown in principle in fig. 7a, and with further details of the entire extrusion in other drawings as will become apparent from the detailed description of the drawings. In connection with the description of product there has already been discussion of the advantages of this modification, and it was mentioned that, provided B2' is less deformable than B1' in its state during and immediately after the dividing, B2' helps to achieve the most regular structure. This should be understood so:

B2' should normally be easier to bring to flow than B1'. However, the higher flowability will mean that the backpressure tends to squeeze B2' towards the walls of the dividing members, whereby the "boundary cellwalls" may become thicker than wanted, while the "bridging cellwalls" may become thinner than wanted. The use of B2' component which shows more resistance to flow than B1' can fully solve this problem. B2' can also, if wanted, have exactly the same composition as B1', but be fed into the extrusion apparatus at a lower temperature to give it higher resistance to deformation, e.g. it may be semifrozen.

It has already been mentioned that in many cases the nesting of the segments of A' in B' is most advantageously a full encasement. The method of the invention comprises two alternative embodiments (which can be combined) to achieve such structures, one being stated in claims 93 and 94, and illustrated in figs 7b and 11b. The use of internal orifices which extend or are interrupted is dealt with here is known from the inventor's earlier patents on lamellar extrusion, but neither for the purpose of producing food products nor for production of any cellular structure comparable in geometric to the structures of this invention.

After the extrusion process, component or components B' must be transformed to a firm cohesive form (optionally this transformation may already start before the dividing process) while component A' may remain generally as it was during the dividing, or be transformed either to become more "fluid" or more fragile.

The alternative options for transformation of B' (which may in some cases be combined) are stated in claims 46 to 57.

In preferred embodiments of the method B' is transformed to harder B by cooling, normally after melt-extrusion. Examples are:chocolate, swollen soya protein or gums. In some cases, when the process is sufficiently slow, e.g. consists in the formation of a gel, cooling of a fluid or plastic solution formed at a relatively high temperature e.g. about 100°. C can be carried out prior to the extrusion, which then can be established at normal ambient, or lower temperature. Examples: adequately strong colloidal solutions of gelatine,

carregenin or Ca-pectinate. Examples of solidification effected by heating of a colloidal solution: adequately strong colloidal solutions of egg albumin or gluten (or gluten-reinforced dough). Examples of reestablishment of the continuity in a previously disrupted gel are: a thixotropic colloidal solution of carregenin with addition of potassium ions (reestablishment on storage for a short time); heating/cooling of disrupted gels of casein or soya protein or starch.

It may be possible for the transformation of B' to B to be the formation of a firm gel by a chemical reaction which is sufficiently slow to allow mixing of the reactants (in B') prior to the coextrusion. As an example, colloidal solutions of pectin or alginate, with additions of Ca-ions and an enzyme which gradually demethylates the polymer, whereby the Ca-salt precipitates as a gel, would be suitable.

Another way of carrying out the transformation to harder B is the formation of a firm gel by chemical reaction between reactants in the B'- and A'-components for instance so that reactants in A' gradually migrate into B'. To gel a B' component which is a colloidal solution of demethylated pectin or alginic acid, there may be used as reactant in the A-component ions of Ca, Mg or Al. Coagulation by change of pH can also be used. As a precaution to fully secure that internal orifices are not blocked by such gel formation, the letter may be adapted in a way which requires a simultaneous change of pH and introduction of such metal ions. In such cases there is used two channel systems for component A', one to carry the said metal ions and introduce it into the B-"cellwalls" from one side, and the other to change pH from the other side of the B-"cellwalls".

Depending on details in the parameters of the extrusion process, a B'-component in form of a colloidal solution will normally become molecularly oriented while it flows towards and through the internal orifices and proceeds along the walls of the dividing members. This orientation can be "frozen" if the gel formation by use of a reactant from the A'-component is sufficiently fast. The material of B is thus often oriented in the boundary cell walls to be directed in the generally z-direction. The "frozen" orientation helps to make the product feel like meat when it is chewed.

As another means for transforming B' to a harder material B preformed solid particles are coagulated to continuous firm matter: fine disperse particles of soyaprotein in a solution containing Ca-ions. The particles may be short fibres, in particular flat fibres which may be so short that they are platelets. For economical reasons flat fibres or platelets from expanded, oriented, fibrillated protein film is preferred. This is particularly useful for the B2'-component in the structure shown in figs. 1a, 6a and b, as made by the apparatus shown in fig. 8. The protein from which the fibres are formed may have been brought to react with a carbohydrate at an elevated temperature to form caramel-related compounds. When there are two B-components B1' and B2', arranged as explained in the foregoing, one method of giving B2' the desired consistency before the dividing (cutting) process, is to form B2' into a gel, at least in part, while it proceeds as narrow flows towards the dividing (cutting) process. This can in some cases be done by admixing a reactant immediately before B' reaches the channels for the narrow flows, and in some other cases by high frequency heating while B' proceeds in the narrow flows towards the array of internal orifices.

Keeping in mind that A in the final product must be more flowable or contain gas, A may in some cases remain in the same generally plastic, gel-form or foam-form state which it had (as A') during the dividing and modelling processes, but in most cases it should either be transformed to a more flowable or more fragile form. More flowable especially when a juicy performance is wanted in the mouth when the "cellwalls" have been broken by chewing.

When A' has a high content of water, there are two ways of making A' adequately semisolid to solid during the dividing (cutting) and modelling process steps, and later more flowable. One way is by freezing and late melting an adequate part of the water or crystallizing sugar and/or other substances dissolved in the water, and later letting it dissolve or melt again. Another way is by use of depolymerisation (hydrolyses) after the extrusion process, preferably by enzymes, such as protease enzymes.

When A' is in frozen or preferably part-frozen state during the extrusion, freezing of B should normally be avoided, except in the case that the or one of

the B' components is also to be cooled to below or about the freezing zone, but B' should preferably prior to the extrusion be cooled down almost to its freezing point and the extrusion process should be carried out as fast as practically possible. The chambers for the narrow flows, and the row of dividing members should in such cases normally be made from metal and then kept at a temperature near the freezing point of B'. Melting of a film from A' during the passage through the die will normally be advantageous rather than harmful, because of the lubrication effect, provided the extrusion velocity is sufficiently high and this film therefore thin.

In order to keep the icecrystals bonded together to an adequate plastic consistency, there should preferably be some amounts of sugar or a watersoluble polymer (e.g. guargum or partly depolymerised protein) mixed into the A'-component, and dispersed shortdigestible fibres are also helpful in this connection.

When leaving the die the product will normally be supplied to a conveyor belt or directly collected in trays and may before this collection or on the belt be cut into suitable pieces. The faces where it has been cut ("the wounds") may be sealed if desired or necessary (to prevent leakage of fluid A) by conventional means. Optionally the entire piece may be enrobed e.g. in a thin film of chocolate.

If the transformation of B' to a firm form B is carried out by heat treatment, this treatment is best done while the product is on the conveyor belt or in the abovementioned trays, and can be by means of microwaves, high frequency heating, contact-heating or by hot air.

Dividing of the extruded continuous product into longitudinal segments can be rationalised. E.g. the extrusion of A- component can be stopped during time intervals long enough to produce a transverse band of plain B components through which the product can be cut without making a "wound". Alternatively the extrusion of B can be interrupted during time intervals long enough to produce a transverse band of plain A-component, through which the continuous product easily can be separated into longitudinal segments without any need

to cut, and the "wound" can then be washed clean of A component (which can be recycled).

Such precautions are normally unnecessary if A in the final form is firm or semifirm (e.g. marzipan or a fruit paste encapsulated in chocolate) since in this case simple cutting may be fully satisfactory.

Examples of different kinds of products according to the invention.

I): Confectionary

I): A: powdered hard caramel and/or finely divided nuts, "sintered" in the extrusion process.

B: chocolate, semimolten during the extrusion process.

2): A: Marzipan, or sweet fruit-mass thickened with soluble protein.

B: see I) 1)

3) A: Icecream, e.g. chocolate icecream, or sweetened frozen yoghurt, melted after the extrusion process.

B: A firm gel of pectin, in disrupted disperse state during the extrusion process and subsequently regenerated by heating and cooling.

When A is based on chocolate icecream with vegetable fat instead of milk fat, 3) can be a suitable substitute of chocolate bars made without use of fatty acids.

II) "Hybrids" between confectionery and protein foodstuffs.

1) A: cheese extruded in plasticised state.

B: see I) 1)

2) A: see I) 1)

B: a disrupted firm gel of soyaprotein or casein, regenerated by heating and cooling.

III) Meat-like foodstuff on basis of vegetable protein.

1) A: a strong soup, or yoghurt with herbs and spices ("chutney"), with addition of small amounts of a thickening agent; in frozen doughlike state during the extrusion process.

B: see II) 2).

2) A: during the extrusion: soya flour dispersed in water thickened by means of part-hydrolysed soyaprotein, and with spices and other aromatic substances, plus proteinase added - after the extrusion: hydrolysed by the proteinase.

B: see I) 3).

IV) Cellular products with contents like sausages.

A: a paste as normally used in sausages, optionally with addition of part-hydrolysed soyaprotein as a thickening agent.

B: see II) 2), or I) 3) or a firm starch gel, disrupted before the extrusion and regenerated by heating/cooling.

This is e.g. a new and advantageous way of using 2nd grade products from the slaughteries.

V) Bread or cake like products.

A: Conventional dough with expansion aid.

B: See II) 2)

The product is baked, whereby the cell structure helps to obtain a fine and even expansion.

The invention will now be explained in further detail with reference to the drawings. In several of the figures there is shown a system of coordinates x, y and z. These coordinates correspond to the indications in the claims and in the general part of the description.

Fig. 1a and b show in the x-z and x-y sections, respectively, and a particularly regular arrangement of the row structure according to the invention with A as "cells" and B1 and B2 as "cellwalls".

Fig. 1c and d show in x-y section two different modifications of the arrangement shown in figs. 1a and b.

Fig. 2 shows, in x-z section, an A/B "cell structure" in a less regular arrangement of the rows, but still falling under the product invention.

Fig. 3 shows in x-z section, a type of A/B-structure which normally should be avoided, but can be useful in cases where the visual effect is most important.

Fig. 4 illustrates in x-z section the modelling of component B' around each segment of component A' mainly by rheological means.

Fig. 5 shows in x-z section an alternative method of modelling B' around A', in which B' first is coextruded with A' to a conjugent B'-A'-B' flow stream, and the modelling mainly is mechanical.

Fig. 6a and b show, in x-z and y-z sections, respectively, a combination of the methods shown in figs. 4 and 5, by which the modelling can be purely mechanical.

Fig. 7a and b illustrate, in x-z section and y-z section, respectively, a modification of the coextrusion arrangement for formation of conjugent B'-A'-B' streams, which modification allows the yield point of component B' to be essentially lower than that of component A'. At the same time the sketches show how the "cell walls" of B-component in x-z planes can be formed.

Fig. 7c corresponds to figs. 7a and b and shows the internal orifices as seen when the exit part is removed. It is drawn in a x-y plane.

Fig. 8a, b and c show, in perspective presentation, x-z section, and y-z section, respectively, a flat coextrusion die suited for manufacturing the product shown in figs. 1a and b, and in which the extrusion of each component is a pulsating ram extrusion coordinated with the movements which transversely divide the flows. 8b is enlarged with respect to 8a and c by about two times.

Fig. 8d shows, in perspective view with the parts moved from each other, a modification to figs. 8a, b and c by which the pulsations in each flow are established by means of a multi-valve which opens and closes in coordination with the movements which transversely divide the streams.

Fig. 9 shows in x-z section another modification of the apparatus of figs. 8a and b, namely a modification in the array of internal orifices and row of dividing members, by which there is obtained a true severing action for dividing the flows.

Fig. 10 shows, perspectively and in partial sections, an embodiment of the methods and apparatus according to the invention, in which the arrangements of transverse movements and ram-extrusion are essentially

different from what is shown in figs. 8a, b and c, but suitable for producing similar products. The drawing does not show the entire extrusion device.

Fig. 11a and b show, in sections y-z and x-z, respectively, another embodiment of the methods an apparatus suitable for making the same kind of products. In this embodiment the dividing movements and the x-direction are generally vertical, while the y-direction is generally horizontal.

Fig. 12 shows in detail the four different positions between the reciprocative movements by which the dividing takes place in the apparatus of figs. 8a, b and c. This figure is made in support of the description of a program for coordination of the different movements and stops.

Fig. 13 represents the test apparatus for determination of compressional yield points.

The typical cell-like structures of the invention, shown in figs. 1a and b are first formed as segmental "filament" structures (see e.g. figs. 4 and 5), and several such "filaments" are then joined to "ribbon" or "sheet" form. The dotted lines (1) indicate the borders between the filaments, where the bond may be so weak that the filaments easily separate from each other in the mouth. This can be advantageous, but the B-material from two neighbour filaments may also be so intimately connected that the borderline hardly can be found in the product.

Referring to the terms in the claims, (2) are the boundary cell walls, (3) the rows of A-cells, (4) the bridging B-cell walls extending generally in z y planes and x y planes, and (5) the bridging B-cell walls extending generally in the x z plane.

These drawings show the presence of two B-components, B1 and B2, of which B1 mainly occupies the boundary cell walls (2) and the bridging cell walls (5) which extend generally in the x z plane, while B2 mainly occupies the bridging cell walls (4) which extend generally in z y planes and x y planes. However depending on the construction of the apparatus (see later), (2) and (5) may also each be partly B1 and partly B2. There are different reasons for using two B-components. One which later will be discussed concerns the manufacturing process, but to this comes that relatively soft or fragile boundary cell walls (2) give a quick release of a fluid (tasty) A-component in the mouth.

while relatively tough bridging cell walls (4) give extra chewing work after release of the tasty component. Both of these effects are felt pleasant in the mouth.

However, still with reference to figs. 2a and b, B1 can be identical with B2, i.e. there will be only one B-component. It will become clear from the apparatus drawings with connected description how these different products can be made.

In figs. 1c and d the rows of A-cells are mutually displaced in two different ways. The manufacture of these structures are briefly mentioned in the descriptions to figs. 7a +b +c, and 11a + b, respectively.

Depending on the rheology of the components during the extrusion, the length of the A'-segments cut, and other details in the extrusion process, the structure of the final product may deviate considerably from the regulatory shown in figs. 1a to d, but still fulfilling the purposes of the product according to the invention. Fig. 2 is an example of such less regular structure. It should be mentioned that the cells also can be made almost spherical, namely by causing each small lump of A' to rotate in the exit part of the coextrusion die. This is further explained in connection with figs. 7a, b and c.

In fig. 2 the cells have a relatively pronounced curved shape (pointing in the direction of extrusion) which is a result of dragging during extrusion. Even in the almost ideal structure of fig. 1a there is shown some curvature. Such shapes or "deformations" of the structure are normally not intended but almost unavoidable due to the friction while the segmental stream passes between the dividing members (and show that the product is an coextruded product). However, if such deformations are exaggerated as shown in fig. 3, they may be harmful. This can happen by inadequate choice of rheology for one or more of the components and/or insufficient modelling of B' around the segments of A'. One of the product claims states preferable limits for the "deformations" in the B-structure. The reference to thicknesses in this claim is illustrated in fig. 3 as follows:

the smallest local thickness of a branch in the vicinity of the branching-off is shown with arrows (6), the smallest thickness of the boundary cell-wall in

the same vicinity by arrows (7), and the biggest thickness of the B-branch by arrows (8).

The biggest thickness of the branch is defined as follows:

from a point of the convex surface the distance to each point on the concave surface is measured, and the smallest distance so found is registered. This is repeated for every point on the convex surface. The (indefinitely many) registered minimum values are compared, and the biggest one so found is the maximum thickness of the branch.

It should be noted that there are cases especially within the confectionery industry where the protecting effect of B is unessential, while there can be advantageous aesthetical values of the patterns of different segments, when the components have different colours or are dark/white, and not least an "abstract" pattern like that of fig. 3 can be interesting. In such cases the product is preferably cleaved (cut) "horizontally" to expose the segmental structure best possible. In these very special cases, the modelling of B' around A' can be omitted, so that there will not be formed any boundary cell-walls of B', but each segment may become "indefinitely" attenuated at the boundaries.

Examples: dark chocolate/white chocolate, dark chocolate/marzipan, white chocolate/caramel, two differently coloured gums.

The simplest way of modelling component B' around small lumps of component A' - seen from a mechanical point of view - is the method which is represented by fig. 4. This shows a section of the last part of the reciprocating "interpositioning" part with internal orifices defined by elements (9), and of the fixed exit part (44) with dividing members (10), each one here shown as a "double knife". The drawing further shows a transformation of separate A' and separate B' flows into segmental A'/B' flows, which then join and form the structure shown in fig. 1a (but with only one B'-component).

The reciprocation is indicated by the double arrow (11). The drawing shows the moment when an internal orifice for A' defined by elements (9) matches with an opening defined by members (10), i.e. just before cutting of a segment of A'. A' has begun to follow the surfaces of (10). However, the

channel defined by these surfaces widens, and when B' flows easier than A' and/or A' shows a lower tendency to sticking, A' will tend to slip away from the surfaces of (7) and become surrounded by B.

Generally component A' should be of plastic, not truly liquid character. B' may be a viscous liquid or better also of plastic character, but should preferably be more fluid than A' (i.e. show lower compressional yield point as defined herebefore). Hereby the back-pressure in the exit part, however, will press B' towards the surfaces of the dividing members, so that the segments of A' come closer to each other, at the same time as their z-dimension is reduced, as shown. The attenuation of the B'-layers between the A'-segments sets a limit to how low the yield point of B' can be compared to the yield point of A'.

In the arrangement of the channels and flows which is shown in fig. 5, the components A' and B' are coextruded to a conjugent B'A'B' flow prior to the dividing (cutting). In this manner component B' will cover or "lubricate" the edges of the dividing members before the dividing of A' begins - as indicated in the drawing - and therefore the risk of A' adhering to the dividing members (10) is essentially reduced.

In order to get the conjugent B'A'B' flows extruded straight from the internal orifices defined by the members (9) into the channels defined by the dividing members (10), the dimensions in the row of members (9) and those in the row of dividing members (10) must be adequately adapted to each other, and furthermore the delivery of components A' and B' must be coordinated with the reciprocations (11) so that the row of members (9) stand still, at least in essence, while A' and B' are delivered in pulsations, and the flow of A' and B' are stopped while this row moves. Similarly is true for the arrangements illustrated by figs. 6a + b and 7a + b + c, which will be described below, while there need not be similar adaptions for the arrangement illustrated by fig. 4.

The arrangement of channels and flows, which is shown in figs. 6a and b represents a combination of fig. 4 and fig. 5. (In this connection it is immaterial that the dividing members are shown without knife-formed edges, this is just done to illustrate that the knife-form normally is not mandatory, (although preferable). It will appear from figs. 6a and b without any further

explanation, that this arrangement, so to say in mechanical way, leads to a modelling of B1' and B2', taken as a whole, around each segment of A'.

As B' is coextruded on each side of A' to a conjugent B1' A' B[1] flow prior to the dividing, it may furthermore be coextruded on each side of B2' to a conjugent B1' B2' B1' flow. In that case the boundary cell walls (2) will consist of plain B1 as shown in fig. 1a. Otherwise these boundary cell walls will consist of a combination of B1 and B2 as it appears from fig. 6a.

The use of two B'-components B1' and B2' as shown in the figs. 6a + b presents a solution to a technical dilemma which inherently exists if there is only one B'-component, namely that on one hand A' can most straightly be formed into regular "cells" if the B' component is essentially more fluid than A' (has a lower compressional yield point), but on the other hand the B'-component then tends to be pressed out towards the walls of the dividing members (10). This tendency was already mentioned in connection with fig. 4. Now with two B'-components, B2' can be chosen to have the same or nearly the same yield point as A', while B1' has a lower yield point (or may be a fluid). The choice of different yield points for B1' and B2' can be matter of selecting different compositions, or it may simply be a matter of using different extrusion temperatures for these two components. There is hereby mainly relied on part-freezing and/or part-precipitation of one or more constituents in the B'-component like in ice-cream - see the examples.

If the compositions of B1' and B2' are chosen so that B2 in the <u>final</u> product exhibits a higher yield point than B1, there can be obtained the product advantages which are explained in connection with figs. 1a + b. However, the apparatus represented by figs. 6a and b can also be used in cases when B2' and B1' are identical in all respects, also with respect to their temperatures during the extrusion.

Still with reference to figs. 6a + b, it has been mentioned above that the yield point of B1' ought to be essentially lower than that of A'. However, again there is a limit to how much more fluid B1' can be made without causing disturbances in the structure, since B1' becomes very unevenly distributed over the width of each of the internal orifices (12) if extruded in relatively small

amounts, and if at the same time there are big differences in the apparent viscosities. This phenomenon is well known in all kind of coextrusion.

However, according to the invention this problem can be solved, as shown in fig. 7a, by the use of springy membranes (13), which close the internal orifices (12) for B1 towards the walls of channels for A' unless the pressure in B1' is conveniently higher than the pressure in A', and which secure that A' never flows into the channels for B1' (and similarly for the coextrusion of B1' with B2'). This system is operated in the way that B1' is injected into A' in pulses shorter than each pulse for extrusion of A, and at a conveniently high pressure. B1' will then primarily form "pockets" in A', but these "pockets" will become evened out during the further flow. (Similar applies to the B1' B2' B1' coextrusion).

The effects of injecting B1' into A' and B2' as here explained while using a B1' component of relatively low yield point and low apparent viscosity, are as follows:

1) Particularly straight dividing (cutting) of the A' and B2' segments

2) Reduced tendency to distortion of the segments during the passage through the exit part of the extrusion die, and

3) A lower back pressure and therefore possibilities of higher throughput.

These important effects are all due to the lubrication with B1' component on the different chamber walls. It is noted that in this arrangement of the "modelling", A' and B2' should exhibit generally equal yield points, otherwise B1' may coextrude only with the one which exhibits the lowest yield point.

The function of the springy membranes may be taken to the extreme so that they lock the passage of A', whereby each flow of A' becomes interrupted by a segment of B1' already at the position (12), i.e. without use of the reciprocating, dividing action. In that case the exit part (44) can be made in one part with (9), or if only one segmental stream or several separate segmental streams are wanted, the "exit part" may simply be omitted, so that (9) will be the end of the extrusion device.

Figs. 7a, b + c further serve to show how to form the bridging B cell walls which extend generally in the xz plane - indicated by (5) in fig. 1b. Right at the end of the internal orifices for the B1'A' B1' and B1' B2' B1' flows there are ribs which are seen in profile as (14) in fig. 7 b, and seen towards their downstream ends as (15) in fig. 7c, while their upstream edges are shown as the dotted line (16) in fig. 7a. As fig. 7b indicates, these ribs are not sharp edged but plane in the downstream end. Corresponding hereto there are ribs in the exit part (44), shown in profile as (17) in fig. 7b. These ribs are sharp in both ends, the sharp edges being shown as dotted lines (18) and (19) in fig. 7a. It will be explained below how these ribs in the row of internal orifices and in the exit part serve to shape bridging B1 cell walls inside the product. Similarly, the "ridges" (20) at the ends of the internal orifices and corresponding "valleys" (21) at the entrance to the exit part (see fig. 7 b) serve to form layers of B1 on both surfaces of the final product.

While each channel for B1' branches out to feed into an A' channel on one side and into a B2' channel on the other side, it also proceeds straight forward to feed directly into the exit part ending in 4 slots (21 in fig. 7c) the length of which in x-dimension corresponds to each opening into the exit part, while the position in y-level corresponds to the levels of ribs (17) or "valleys" (21), as the case may be.

When the reciprocating movement is stopped in the position where the B1' component is fed directly into each chamber in the exit part, while the internal orifices for the B1'-A'-B1' flows and the B1'-B2'-B1' flows are blocked by the dividing members (10), the "valleys" will become filled with B1' component, and similarly the upstream part of the ribs (17) will become fully covered with B1'. After the following step of reciprocation, a B1'-A'-B1'- flow or a B1'-B2'-B1'-flow (as the case may be) will be fed into the chambers in the exit part (the internal orifices for direct B1' extrusion being blocked), but due to the geometry of ribs (14) and (17) and "ridges"/"valleys" (20) and (21) these flows will never get in contact, either with ribs (17) or with the xz surfaces of the chambers in the exit part. These ribs and chamber surfaces will all the time be

covered with B1' and will therefore create "bridging cell walls" of B1' in the final product.

By making adjacent dividing members (10) and/or adjacent ribs (17) of mutually different lengths, and at the same time suitably adjusting the length into which the flows are cut, it is possible to make the segments of A' rotate and acquire a generally cylindrical or spherical shape.

Figs. 7a, b + c show the most complicated but usually also best method of treating the flows. However, the individual features which are presented here can of course be used in other combinations. Thus the use of springy membranes (13) and of ribs etc. are two different features which are not necessarily combined. And further the coextrusion of B1' into the B2' flow - which requires that A' and B2' have practically equal yield points - and the direct extrusion of B1' into the channels in the exit part may both be omitted. In that case there should not be any ribs (14) and ridges (20) in the B2' channels, and therefore it will become B2' which covers the ribs (17) and the xz surfaces of the chambers in the exit part.

Finally, fig. 7b shows the transport belt (23) which takes up the extruded product, and on which there normally are carried out further operations. It also shows a flab (23) which should be adjustable. This is not mandatory but can be a help for adjustment of the back-pressure in the exit part to avoid on one hand the occurrence of cavities in the extruded product, and failing flowing-together of the segmental streams in the exit part (44), and on the other hand an exaggerated pressing flat of the segments of A' components.

By modification of the dividing members (10) shown in figs. 7a + b, the apparatus can be made to produce the structure represented by fig. 1c. For this purpose the upstream edges on (10) should still be straight and generally perpendicular to the plane defined by the array of flows, but after the dividing, the different "levels" of segmental flows should gradually become staggered ("level" meaning this space between two adjacent ribs (17) or a "valley" (21) and the adjacent rib (17)). The downstream edge of each dividing member (10) must have a staggered shape corresponding to that wanted in the product, and the sidewalls of (10) will gradually adapt to this shape. Normally the staggering

of the construction should not extend over the full x-dimension of the apparatus and the product, but should be zero at the sides of the apparatus and at the x-boundaries of the product.

Figs. 7a + b can also illustrate the manufacture of a product having two different series of "cells", A1 and A2, and only one component B for the "cell walls", in other words the designations A', B1' and B2' in the drawings should be substituted by A1', B^1 and A2', respectively. However in that case each of the internal orifices for B in the row of orifices shown in fig. 8c should not be interrupted as in this drawing. One of the two A components may e.g. be waterbased and the other one fat/oil based, while B in the final product normally should be a gelled composition.

The total coextrusion die represented by figs. 8a, b + c, consists of a stationary inlet part (24), a reciprocating "interpositioning part" (25) with chambers for the interposed narrow flows defined by walls (26) and ending in the array of internal orifices defined by elements (9), and a fixed exit part supplied with dividing members (10). The "interpositioning part" (25) is guided by tracks 102 in the fixed base plate 101. The reciprocation is indicated by the double arrow (11) but the means for this reciprocation are now shown. The apparatus is normally installed in such way that the section shown in fig. 8b is really horizontal or close to horizontal. The three components A' (for "cells") $B^{1'}$ and $B^{2'}$ (both for "cell walls") are extruded from the inlet part (24) through 3 relatively long and narrow orifices (27 for A', 28 for B2' and 29 for B1') by conventional means, i.e. by pumping or extrusion. The apparatus for this are not shown. The inlet part (24) is outside the section shown in fig. 8b, but the position of the walls for the A'-chamber, the B2'-chamber and the B1'-chamber in this part are indicated by the dotted lines (30), (30a) (31), (31a), and (32a), respectively. Prior to or in connection with the conventional pumping or extrusion, each of the components is intimately blended and given the appropriate plastic condition, normally by semi-melting or semi-solidification (the latter as in the manufacture of ice-cream). Since the rheological properties in such semi-molten or semi-solidified state may depend very critically on the temperature, temperature-control may not be sufficient, but a constant

measurement of the apparent viscosity may be needed for feed-back control. The temperatures in each of the 3 components - which may be different temperatures - are maintained during the passage through (24) by a circulating heating/cooling liquid. The system for this is not shown. Similarly, there is kept appropriate temperatures in the reciprocating part (25) and in the exit part, the heating/cooling means for which are not shown.

The flow of components through each of the 3 exits from the stationary feeding part (24) is not constant, but is made intermittent by means of a pressure varying device, e.g. hydraulic cylinder (33) connected to each flow (but only one is shown in the drawing). For each component the minimum pressure is close to zero, while the maximum pressure may be several hundred bars. There is a steady measurement of pressure in each component with feedback to the pump/extruder so as to secure that the maximum pressure becomes almost the same in each stroke. (Devices not shown). The pressure is raised while the chambers in part (25) become filled. During that period the reciprocation of (25) is stopped, and two clamps (e.g. hydraulic clamps) of which one is shown as (34) in fig. 8a, secure a tight sealing between the 3 exit slots of part (24) and corresponding rows of openings in the inlet plate (24a) on part (25). After reduction of the pressures in the 3 components almost to zero, the sealing between parts (24) and (25) is released - clamps (34) should only move a fraction of a mm to achieve this - and the "modelling" processes, including the reciprocations of (25), are started. These processes are further described below. Later on the firm sealing is again established and pressure applied to feed the channels in (25).

In the reciprocating "interpositioning" part (25) there is a number of narrow channels for A', B1' and B2', respectively. In fig. 8b it is written in each channel which component it conducts.

These are closed channels, except at their exit end and except for the above mentioned rows of openings in the inlet plate (24e) towards the corresponding orifices in the fixed inlet part (24). Thus, since fig. 8c shows a section which goes through one of the A'-channels in the reciprocating part, it

shows this channel opening towards the A'-channel in feed-part (24), while it does not open towards the B1' and B2' channels in the feed-part.

Oppositely to the exit, each channel in the reciprocating "interpositioning part" is closed by a ram (35) moved forward through a wire (36) and backward by means of the pressure in the extruded component while the channel is filled from (24). The function is further described below. All rams for A1' are synchronised by fixing the wire which drive them forward to one and the same connecting bar (37), driven by actuator (40) through connectioning rod (40a) - the arrangement is presented very schematically in fig. 8c without showing guiding tracks for (37). Similarly, all rams for the B2'-flows, except the B2'-flows closest to the sides of the coextrusion device, are all fixed to one connecting bar and driven by actuator (41), through connecting rod (41a), while all rams for the B1'-flows except those closest to the sides of the device, are all fixed to connecting bar (39) and driven by actuator (42) through connecting rod (42a). Normally there will be more than the 3A'-flows, 4 B2'-flows and 8 B1'-flows, which are shown in these drawings. For reasons which will appear from the explanations in connection with fig. 12, the mentioned 4 rams at the sides of the device are each driven separately by individual actuators.

The actuators (40), (41) and (42) are conveniently but not necessarily operating hydraulically. The coextrusion and "modelling" processes take place as explained in connection with figs. 7a, b + c. Preferably, the ram extrusion is not established by steady reciprocations of the rams, but in a series of pulses forward (e.g. 5-20 pulses) with (25) changing its position between each pulse, each series followed by one movement of each ram backward to its starting position, while the chambers again are filled from (24). This is explained in detail in connection with fig. 12.

During each "kick" (or pulse) on a ram the pressure may exceed 100 bars, and each "kick", including the time to "cut" the flows and bring the "interpositioning part" (25) into the next position ready for a new "kick" should preferably last less than 0,1 sec.

At each of the 3 entrances to the channels in the reciprocating part (25), i.e. immediately following the exits (27), (28) and (29) in the feeding part (24),

there is installed a non-return valve (43), shown in cross-section in fig. 8c. Seen in x-direction these 3 valves extend in the full length of the exits (27), (28) and (29). They prevent any substantial loss of material by backflow which otherwise would occur when the cylinders (34) partly have eliminated the sealing between part (24) and part (25). Likewise, the sealing of the connection between the reciprocating "interpositioning part" (25) and the exit part (44) with the dividing members (10) must be firm while there is extruded through this connection and while the rams are moved backward during a filling period. However, this sealing must be much looser while (25) is in movement, otherwise the friction may become a problem. The hydraulic clamps (45) take care of the tightening and loosening of this sealing by movement amounting to only a fraction of mm. The abrupt reciprocating movements of (25) which are indicated by the double arrow (11) - can conveniently but not necessarily be established in fully mechanical way by means of a cam (not shown). This is further explained in connection with fig. 12.

In addition to components A', B1' and B2' there is also, in smaller amounts, used a component C for lubrication of the rams. This is applied under pressure in conventional way, but the means for this are not shown. C must of course be conveniently compatible with the other components, i.e. it must not ruin the mechanical stability of the final product, and it must be suited for food applications (see the examples).

The conveyor belt (22) which already has been mentioned in connection with fig. 7b, is preferably advanced abruptly with stops corresponding to the short periods (e.g. 0,5 sec.) while the channels in part (25) receive material from part (24).

At the position where the coextrusion device delivers the product to the conveyor belt, there may a knife for cutting the product into convenient lengths (not shown), and there may also be other devices in connection with the conveyor belt, e.g. for heat treatment of the product.

In many cases the packing of the product can take place on this conveyor belt, and to do so a packaging film can be laid on the belt before this receives the cut-out piece of product. This film can be automatically wrapped

over each piece, and if the belt is accelerated for a short moment after each cutting action to separate the pieces from each other, the wrapping can be done from all 4 sides. If the packaging film is an aluminium film, this can sufficiently support the product during the solidification of the B'-component or - components (solidification by heating or simply by storage).

Coordinated with the cutting at the entrance to the conveyor belt, the extrusion of A'-component may be interrupted for a short period, while there still is extruded B'-component or - components, so as to secure that the cuts traverse B' only. This is advantageous if A in the final product is fluid.

"Bleeding" of A-component from the ends of the product pieces can alternatively be avoided by a conventional coating of the cut ends or of the entire product (e.g. with chocolate or similarly) preferably while the product is frozen.

It should be mentioned that the use of a conveyor belt is not always needed. Furthermore the hydraulic clamps (34) and (45) (or similar non-hydraulic clamps) and the non-return-valve (43) are not indispensable but are very useful for achieving a high throughput.

Instead of establishing the pulsating extrusion by means of rams, it can also be done under use of a valve arrangement as shown in fig. 9. Between the fixed inlet part (24) and the reciprocating "interpositioning part" (25) there is inserted a shutterplate (46), which also follows the movements of (25) indicated by the double arrow (11), but superposed on this movement, (46) is driven forward and backward relative to (25) - see double arrow (47) - by means of an actuator fixed to (25) (not shown). In firm connection with (25) there is a coverplate (48). Both shutterplate (46) and coverplate (48) have 3 rows of slots, (49) for the A'-component, (50) for the B2'-component, and (51) for the B1'-component. These slots in (48) correspond exactly to the respective channels in (25), and the slots in (46) exactly match those in (48) when the shutter stands in position "open", while the shutterplate completely covers the slots in (48) in position "closed". Before this shutter arrangement there is not installed any devices to produce pulsations in the extrusion pressure. This

system is mechanically simpler than the ram extrusion, however due to frictional problems it is slower.

If one shutterplate is used for all 3 components, they will of course be extruded in the same rhythm, but it is also possible to use one shutterplate for each component.

By means of the modification shown in fig. 9, the dividing of the flows will take place by a very efficient "severing action" and it will even be possible to divide flows which contain fibres longer than, say 2 mm. Since the channels in the exit part are biased, seen in relation to the z-direction of the apparatus, the take-off of the product from the device by means of a conveyor belt must similarly be biased.

The drawing represents a modification of the simple "modelling" shown in fig. 4, but this type of "severing action" can also be applied to the more complicated methods of "modelling", even to the method shown in figs. 7a, b + c.

In the embodiment represented by fig. 10, there is a separate "ram-part" (52) for the ram extrusion, and in this part there is one ram only for each component A', B1' and B2', namely rams (53), (54) and (55) respectively. This "ram-part" is a fixed part like the "feed-part" (24), and the feeding takes place through slots (56) for A', (57) for B1' and (58) for B2'. In order to allow the passage of B1' into the middle chamber of the "ram-part", the ram (55) is also supplied with a slot (59) of with a row of slots.

The "feed-part" (24), which is not shown here, comprises hydraulic pressure varying devices and no-return valves like (33) and (27) in figs. 8a + b, but since the "ram-part" (52) does not move, there is no hydraulic clamp like (34).

The reciprocating "interpositioning part" (25) - reciprocations indicated by double arrow (11) - which slide upon the "ram-part" (52) intersperse the 3 components and bring them into array by means of the converging channels (59').

The drawing ends where the flows have been brought into array, but in actual fact this embodiment also comprises devices for the dividing and

"modelling" of the flows, and the "interpositioning part" (25) may e.g. end in constructions as shown in figs. 4, 5, 6 a + b, or 7a, b + c, while at the very end of the coextrusion device there can be an "exit part" (44) with "dividing members" (10) as shown in the other drawings. There can also be a conveyor belt to receive the extruded product.

Furthermore there can be one or more hydraulic clamps like (45) in figs. 8a and b. In this embodiment of the invention, they serve to seal off and loosen not only the connection between the "interpositioning part" (25) and the "exit part", but also the connection between the "ram-part" (52) and the "interpositioning part".

In other respect, this embodiment of the invention is normally generally similar to what is shown in figs. 8a, b + c and explained in connection with these drawings.

The apparatus of figs. 11a + b consists of an "inlet part" (not shown, but constructed as explained in connection with fig. 10) a fixed "ram-part" with 4 rams, (53) for A', (55) for B2' and two (54) for B1'. There is no horizontally reciprocating "interspersion part", but the "ram part" is immediately followed by the "exit part" with the dividing members (10). In this embodiment of the invention, the exit part is not stationary, but reciprocates up and down in a pivoting movement, as indicated by the double arrow (11), around the axis (60). This axis goes through the level on the conveyor belt (22) where the product is delivered. It is clear that if the exit part would be allowed horizontal movements the product would be torn (unless the conveyor belt would be similarly moved, and that would be very unpractical), but the pivoting movements which appear from these drawings will not damage the product in this way, provided the amplitude is sufficiently low and/or the exit part is sufficiently long.

The "modelling" process is generally similar to what is shown in figs. 7a, b + c, but note that the x-direction is generally vertical and the y-direction generally horizontal. Other differences between the features shown here and those shown in figs. 7a, b + c are

a) Only one A'-flow, two B1'-flows and two B2'-flows. (There could be a few more).

b) 9 instead of only 2 sets of ribs (14) and (17), now to form vertical "cell walls". (This number can of course be varied).

c) B1' forming a conjugent flow with A' only and not being directly passed into the exit part. (This is not essential for the embodiment).

Like in the other embodiments of the invention there are clamps (45) i.e. hydraulic clamps (45) adapted to firmly press the exit part towards the preceding part when efficient sealing is needed, and loosen the connection during the periods of relative movement between the parts.

The structure shown in fig. 1d can be produced with this embodiment of the apparatus of the invention, when suitably modified. The ribs (17) in the exit part (44) should not point straight in the machine direction, but in the "upper level" e.g. point to the right and in the "lower level" to the left. This leads to the formation of two mutually displaced rows of cells. To achieve three mutually displaced rows as shown in fig. 1d the exit part must have three inlets instead of only the two which are shown. Near the left and right edges of the extruded product the displacements should be near zero.

The following will explain in detail the programme for operating the coextrusion and "modelling" process, when the apparatus shown in figs. 8a, b and c is used. Fig. 12 shows the different stop-positions of the reciprocating "interpositioning part" (25) relative to the fixed "exit part" (44). There are 4 such stop positions, namely:

<u>Position I</u>, in which the upstream ends of the dividing members (10) cover the entire row of internal orifices defined by the members (9), so each of the 3 sets of flows (B1' A' B1'), B1' and (B1' B2' B1'), respectively, are stopped, and any retraction of material from the channels in the exit parts also is prevented, provided there has been established a firm sealing between the two apparatus parts (25) and (44) as achieved by means of the hydraulic clamps (45).

<u>Position II</u>, the symmetrical position, in which there is free passage for all plein B1' flows into the exit part (44) and is shut-off for all of the (B1' A' B1') and (B1' B2' B1') flows, still provided a firm sealing has been established.

<u>Position III</u>, the position in which part (25) is most to the left, and in which there is free passage into the exit part (44) for all conjugate flows (B1' A' B1') and (B1'

B2' B1') except the farthest right (B1' B2' B1')-flow (which threfore must not be acted on by a ram), and is shut-off for all plain B1'-flows, still provided a firm sealing has been established.

Position IV, the position in which part (25) is most to the right, and in which there is free passage into the exit part (44) for all conjugent flows (B1' A1' B1') and (B1' B2' B1') except the farthest lefti (B1' B2' B1')-flows (which therefore must not be acted on by a ram), and is shut-off for all plain B1-flows, still provided a firm sealing has been established.

If in any given chamber in exit part (44) the extrusion during stops in position III will inject a piece of a (B1' A' B1')-flow, then the extrusion during stops in position IV will inject a piece of a (B1' B2' B1')-flow in the same chamber (and *vice versa*).

Starting situation for the following program is a situation in which (25) has been brought into position I, hydraulic clams (45) and hydraulic clambs (34) both are under pressure to make firm sealing between the "inlet part" (24) and the "interpositioning part" (25), and between this part (25) and the exit part (44), and furthermore each of the rams (35) are in their foremost position, while the pressure in the inlet part (24) is close to zero in each of the 3 components, as regulated by the hydraulic pressure variating devices (33).

1st sequence of steps: The pressure in the inlet part (24) is increased in each of the components by means of the devices (33) so as to inject each of the components into the channels of part (25) and drive each of the rams (35) to its most backward position. If the rams are adapted to be positively pulled backward (which they are not in the construction shown in fig. 8a and c), this pull should also be activated but should be stopped when the farthest back position has been reached. After this devices (33) bring down the pressure of each component in the inlet part almost to zero, then the hydraulic clamps (34) and (45) release the two sealing pressures to allow part (25) to be moved, whereafter (25) is moved to position II. Finally clamp (45) is activated to establish a firm sealing between part (25) and part (44) (but clamp (34) is not activated).

<u>2nd sequence of steps</u>: All rams for extrusion of B1' are pushed one step forward by means of the actuators (42), after which the sealing between part (25) and part (44) is released, (25) moved to position III and a firm sealing again established between part (25) and part (44).

<u>3rd sequence of steps</u>: All rams for B1' except the one or farthest left one are pushed one step forward at a particularly high velocity to inject B1' evenly unto the A' and B2' flows. Then all rams for A' and B2', except the one farthest or the left B2' ram are pushed one step forward, after which the sealing between part (25) and part (44) is released, (25) moved to position II, and a firm sealing again established between part (25) and part (44).

<u>4th sequence of steps</u>: Identical with the 2nd sequence, except that towards the end of this sequence the movement of (25) goes to position IV.

<u>5th sequence of steps</u>: Identical with the 3rd sequence, except that it is the farthest right B1' and B2' rams which are not activated.

The 2nd to 5th sequences of steps are repeated, e.g. 4-9 times. However at the very end of this procedure, part (25) is not moved to position II but to position I, after which a firm sealing is established not only between (25) and (44) but also between the "inlet part" (24) and (25). Now the total sequence of steps is finalised - it should preferably take no more than about 1 second - the channels in (25) become refilled and all continues as described above, starting with the "1st sequence of steps".

The above programme concerns the most complicated but generally most advantageous "modelling" process, in which B1' is coextruded with both other components prior to the dividing, and also goes directly to the exit part (44) through a separate set of orifices. If as an example, there are only 2 sets of flows extruded out of part (25), namely a conjugent B1' A' B1' flow and a plain B2' flow, then the positions shown in fig. 12 will be substituted by 3 positions only, position II being omitted (and position I will conveniently be a symmetrical position). On basis of the principles which appear from the above programme, it will be easy to set up analogous programmes for the different processes by which the "modelling" can be carried out.

It has already been mentioned that the change between the different position of part (25), also referred to as the reciprocations, and indicated by arrow (11), most conveniently is carried out purely mechanically by means of a rotating cam (although other methods of course also can be applied). Then one revolution of the cam shaft should preferably correspond to the total sequence of steps, from the start of filling the channels in (25) until the apparatus again is ready to make a new start of filling. The mechanical movement of the cam can conveniently also determine when the other operations are started, while electronic timers or registrations of actuator positions conveniently determine when these other operations are stopped. The actuators for the rams are preferably either hydraulic or are step-motors in connection with spindels, while the clamps, referred to as being hydraulic, also e.g. can be fully mechanical.

In many cases it will be possible to avoid the use of non-return valves (43), however this will make the production slower.

With reference to fig. 8b and fig. 12 the width of each channel in (25) - prior to the merging of B1' with A' and B2' at the end of this diepart - can as a suitable example be 2 mm and the width of the channel walls (26) 1 mm. This means that the distance between adjacent dividing members (10) as measured between their downstream edges will be 2 + 1 + 2 + 1 = 6 mm. Further more in this example the width of each orifice (9) in part (25) can conveniently equal the distance between adjacent upstream edges of the dividing members (10) and be 1 mm. On each of the dividing members, the surface which gives the member shutter effect will consequently cover 5 mm in the x-direction.

It has been mentioned that the methods according to the invention also can be applied to circular extension. In that case the embodiment shown in fig. 10, but modified for rotation, is most suited. The material can leave the extrusion device as segments of the circle and then be conveyed by belts on their two major surfaces.

Fig. 12 part (25) may still be reciprocated, but is preferably rotated one way only, with stops in the 4 positions I, II, III and VI. This does not mean that the motor or other heavy driving means have to stop since the drice may be

established through a sliding or spring coupling, while the short stops of rotation of (25) are established by the hydraulic clamps (45) and additionally further brake devices.

Although the extrusion methods and apparatus of the invention primarily have been developed with a view to coextrusion of cellular foodstructures the "modelling" of B' around A' by a suitable coordination of extrusion in pulses and relative movements of dieparts, can find other important uses in connection with extrusion of cell-formed polymer products or ceramic products. In such cases the nesting of A in B normally should only be in two dimensions, in other words A should extend from one major surface of the product to the other major surface. The cell structure may serve decorative purposes, when A and B have different optical properties, or if A can be fully or partly removed after the extrusion. A can e.g. be paste which can be leached out. The cell structure may also have a real technical function, e.g. in the manufacture of catalyst products, where A can be a porous material e.g. ceramic material containing the catalyst, and B,, e.g. also ceramical, can act as reinforcement in all 3 dimensions.

As mentioned in the introduction to this specification there does not, to the knowledge of the inventor, exist any official standard for measurement of compressive yield point. Neither does there exist any commercial equipment for such measurements, when the sample to be tested is only about 1 or a few grams as needed in practice for the measurements on a stack of B "cell-walls" cut out the final product of the invention. It was therefore necessary to construct a test device and decide on the conditions of testing.

Fig. 13 shows the device. The sample (61) is placed on a metal base (62) which is supplied with cooling/heating and temperature controlling means for the testing of semi-frozen or semi-molten A' and B' components. The device has a square foot (63) (dimensions see below) and is pressed into the sample by means of a piston operated by air, the pressure of which can be exactly adjusted to give a well defined and variable pressure on the sample. The penetration of the foot (63) into the sample is shown by the indicator (65) which

is driven by rack and pinion (66). The indicator is here shown in simple way, but is preferably a pen to write compression/time diagrams.

When the apparatus is used to test semi-frozen or semi-molten material, the foot (63) is first pressed down in the base (62) for a long time enough to give it the adjusted temperature, and the semi-frozen or semi-molten samples are taken out from the blending apparatus, and very quickly cut in shape and tested.

When B cell-walls from the final product are tested, they are cut out as pieces which must be as plane as possible. These pieces are then stacked up to an assembly (61) in the right shape (see below) under use of a holder or "mould". Low pressure is applied to the foot (63) to make the stack compact without causing any flow, and the holder is opened and removed. The pressure is gradually increased until a permanent flow exceeding 10% compression per minute is observed. For exact measurements the testing has to be repeated several times after a first range finding test for the approximate value.

Size of the foot (63) and sample (61):

The foot is square shaped, and for measurement of yield values lower than 200 g cm^{-2} it measures 20 mm x 20 mm, for yield values between 200 to 10,000 g cm^{-2} it measure 10 mm x 10 mm, and for higher yield values 5 mm x 5 mm.

The horizontal surfaces of the samples are also made square formed with the edge of the square double the measure of the foot, i.e. 40 mm, 20 mm and 10 mm, respectively.

The height of the sample is half its length and width, i.e. 20 mm, 10 mm and 5 mm, respectively.

The following examples illustrate the invention.

<u>Examples</u>

General information relating to the examples:

Equipment: A laboratory extrusion device generally similar to the apparatus shown in fig. 10, however with feeding in the three chambers in the inlet part without any continuously operated pump or extruder - it is not necessary since the extrusion involves less than 1kg of each component - but

with an intermittently operated stamp as shown by (33) in figs. 8a and c. Joining of the flows: in all examples conjugent B1' A' B1' flows, but no coextrusion on the sides of the B2' flows, as shown in figs. 6a and b. Use of the membranes (13) shown in fig. 7a, except in examples 2 and 5, where the yield point of B1' is lower than but relatively close to that of A'. (In the other examples the difference is much bigger).

Experiments in preparation of the examples: The purpose of these experiments is to choose in a simplified way the best yield point for each of the components A', B1' and B2'. For A' and B', clay with different contents of water was tried and for B1' doughs made from wheat flour with different contents of water. A number of combinations were tried.

The coextruded samples were dried with hot air, then sliced up with a razor blade, and magnified photos were taken (there had been added different pigments to the three components).

Chosen as the most suitable was:

A': clay with 26% contents of water, showing yield point 1,6kg cm^{-2}. (20°C).

B2': the same as A'.

B1': a dough of 1 weight part four to 1,5 weight parts water, showing yield point 25g cm^{-2} (20°C).

It was therefore decided to aim at these yield points in each of the examples except in examples 1 and 2 where this is probably not possible.

<u>Example 1</u>

Component A: Marzipan

Component B1: Dark chocolate

Component B2: The same dark chocolate

Lubricant for the rams: sunflower oil.

It was found that the marzipan had yield point 400 g per sq. cm. To achieve the same yield point in the chocolate as wanted in the B2' component, it was found that its temperature should be 29.5°C. To achieve the yield point 25g per sq. cm in the chocolate as wanted in the B1' component, it was found that the temperature should be 31°C.

Temperature for the extrusion apparatus: 35°C. Temperature for the marzipan at the entrance to the extrusion die chosen to be 20°C.

Yield point of the chocolate (A-component) at 20°C, as measured on a sample cut out from a plate of the chocolate, is 56kg cm^{-2}.

Example 2

Components B1' and B2': powdered parmesan cheese. The yield point of the mass at 20°C is measured to be 1.3kg cm^{-2}.

Component A'; a dough adjusted by an admixture of bran to show approximately the same yield point, consisting of: 3 weightpart wheat gluten, 15 parts oat bran, 18 parts water, and small amounts of a baking powder.

Lubricant for the rams: egg white.

Extrusion at 20°C.

Aftertreatment: Heating to about 100°C to melt the cheese and bake the dough, by which it also expands. Yield point of the solidified cheese at 20°C:20kg cm^{-2}.

Example 3

Component A'; honey, viscous fluid at 20°C. The preferable yield point for the extrusion, 1.6kg cm^{-2}, was approximately obtained at -15°C which therefore is the chosen extrusion temperature for this component.

Components B1' and B2': Identical compositions, namely 60 parts by weight egg white powder + 150 parts oat bran + 180 parts water. At -1.5°C it shows approximate yield point 25 g cm^{-2}, this temperature therefore is chosen for B1'. At 30°C is shows approximate yield point 1,6kg cm^{-2}, this temperature therefore is chosen for B2'.

Lubricant for the rams: egg white.

Temperature chosen for the extrusion apparatus: + 1°C.

The extruded product is heated to 80°C to make the egg white form gel.

Yield point of the solidified component A: 6,6 kg cm^{-2}.

Example 4

Component A': 470 parts by weight whole milk yoghurt + 25 parts flour sugar + 2,5 parts sodium salt of carboxymethylcellulose (thickening agent) + 10 parts calcium lactate. The latter is admixed in order to react with pectin in the

B1' and B2' components to make them solidify. The thickening agent is preblended with the sugar in order to facilitate the dissolution process.

This component acquires the approximate yield point 1,6 kg cm^{-2} at -5°C, which therefore is chosen for the extrusion of this component.

Components B1' and B2': the same composition, namely: 40 parts by weight pectin (50% hydrolysed grade) + 20 parts flour sugar (dryblended with the pectin) + 360 parts demineralized water. At -1°C it shows the approximate yield point 25g cm^{-2}, this temperature therefore is chosen for B1'. At -1.3°C it shows approximate yield point 1,6 kg cm^{-2}, this temperature therefore is chosen for B2'.

Lubricant for the rams: cream.

Temperature chosen for the extrusion apparatus: + 1°.

Solidification of B1' and B2' by 2 days storage by which the calcium ions migrate into the A' component and transforms that into a gel. Yield point of the latter 1,2 kg cm^{-2}.

Example 5

A' component: 8 parts by weight butter + 9 parts sesame oil.

At -14°C this acquires approximate yield point 1.6 kg cm^{-2}, and therefore this temperature is chosen for the extrusion of A'.

Components B1' and B2': the same composition, namely 15 parts by weight oat bran + 3 parts wheat gluten + 18 parts water.

+1°C the yield point is approximately 1kg cm^{-2}, and this temperature is chosen for both B1' and B2'.

Temperature of extrusion apparatus: +1°C.

Lubricant for the rams: sesame oil.

Solidification of B' by storage for a short time at 100°C.

Yield point of the solid B: 1,0 kg cm^{-2}. The solid B is microporous.

Claims

1. A three-dimensional food product, elongated in at least one dimension (the z-dimension) and consisting of at least two components which have been coextruded to become interspersed with each other, in which one or more cells of components A are surrounded at least in the xz plane by one or more components B which form cell walls surrounding the A component characterised in that the or each B component is a solid (including a viscoelastic solid) at 20°C the cells of components A are arranged in at least two mutually distinct rows extending generally in the z direction, each said row of cells being separated from the adjacent row by a generally continuous (in the z-direction) boundary cell wall of B component, and either a) A having no compressional yield point (being a fluid) at 20°C or having plastic, pseudoplastic or viscoelastic consistency at 20°C and having a compressional yield point YP_{A20} at 20°C which is less than 0.5 x the compressional yield point of B at 20°C (YP_{B20}) or b) A being an expanded material containing at least 50% by volume gas.

2. A product according to claim 1 in which each cell of A extends in a generally Y direction substantially from a position at or adjacent to one xz face of the food product to a position at or adjacent the other xz face.

3. A product according to claim 1 in which the boundary cell wall is formed of a component B_1 and the product has bridging cell walls branching from and extending at least part way in a generally x direction towards the adjacent boundary cell wall, the bridging cell walls being formed at least in part of a B component B_2 being different to B_1.

4. A product according to claim 1 in which the boundary cell wall is formed of at least two different components B_1 and B_2 and the product has bridging cell walls branching from and extending at least part way in a generally x direction towards the adjacent boundary cell wall, the bridging cell walls being formed at least in part of B_2.

5. A product according to claim 3 or claim 4 in which the components B_1 and B_2 have different yield points at 20°C, preferably in which the yield point of B_1, $YP_{B1(20)}$, is in the range 0.1 to 0.5 of the yield point of B_2,$YP_{B2(20)}$.

6. A product according to claim 1 in which each of the cells of A extend part way between the two xz faces, and in which two or more cells span the distance between the two xz faces and are separated from one another in the y-direction and in which there are B components arranged between adjacent cells of A which are separated from one another generally in the y direction and forming cell walls around each A cell, so that the A cells are substantially enveloped by cell walls of B.

7. A product according to claim 6 and claim 4 in which the B components between adjacent cells of A separated in the y-direction comprises B1.

8. A product according to claim 1 in which the B component is formed of a single component and in which there are bridging cell walls branching from and extending at least part way in a generally x direction towards the adjacent boundary cell wall and around each cell of A.

9. A product according to claim 1, <u>characterised in that</u> if the bridging cell walls that is walls other than the boundary cell are attenuated in the vicinity of the boundary cell wall the local thickness the attenuated wall is generally not any thinner than 1/15 of the thickest portion of said wall.

10. A product according to claim 8, <u>characterised in that</u> the said boundary cell walls of B-component extend in waved or zig-zagging manner about a plane extending in the zy plane.

11. A product according to any of claims 5 to 10 in which the bridging cell walls which branch off from the boundary cell walls, considered in a yz plane, branch off substantially perpendicularly to the boundary cell wall at the branching point.

12. A product according to any preceding claim which further comprises edge boundary cell walls of B extending substantially continuously generally in the z- direction along or adjacent to each yz face of the product.

13. A product according to claim 1 in which each boundary cell wall is substantially planar, lying generally in a yz plane.

14. A product according to any preceding claim in which the cross section of cells of A in the xz plane has an average dimension in the z direction in the range 0.5 to 10 mm, preferably in the range 1-5 mm.

15. A product according to any preceding claim in which the average cross-sectional area of cells of A in the xz plane is in the range 0.5-100mm^2, preferably 1-25mm^2.

16. A product according to any preceding claim in which the average row separation is in the range 1-25mm, preferably 3-15mm.

17. A product according to claim 16 in which the boundary cell walls have a minimum thickness in the x direction in the range 5-50% of the average row separation, preferably at least 10%.

18. A product according to any preceding claim in which the bridging cell walls (being cell walls between cells of A other than boundary cell walls) have a minimum thickness of 0.1 mm, preferably a minimum thickness of 0.5 mm.

19. A product according to any preceding claim, characterised in that A in the final form of the product at 20°C is fluid.

20. A product according to any of claims 1 to 18, characterised in that A in the final form of the product at 20°C is a plastic pseudoplastic or viscoelastic material cell having a compressional yield point, YP_A lower than 1000 g cm^{-2} and preferably lower than 500 g cm^{-2}.

21. A product according to claim 20, characterised in that A consists of a blend of on one hand short fibres, nut-, grain- or shell-pieces, film-pieces or flakes and on the other hand a water based solution or gel.

22. A product according to claim 20, characterised in that A consist of a blend of on one hand short fibres, nut-, grain, or shell-pieces, film-pieces or flakes, and on the other hand an oil.

23. A product according to any preceding claim, characterised in that B is a gel.

24. A product according to any preceding claim in which B, optionally reinforced with short fibres, or grain-, shell- or film-pieces or flakes, has a yield

point, YP_B, of at least 200 g cm^{-2}, preferably in the range 500 to 80,000 g cm^{-2}, and more preferably no more than 60,000 g cm^{-2}.

25. A product according to any preceding claim, characterised in that B is based on fat , oil or wax with additions for the taste, preferably it consists of chocolate.

26. A product according to any of claims 1 to 24, characterised in that B is based on protein.

27. A product according to any of claims 1 to 24, characterised in that B is a microporous agglomerate of particles containing water in the pores, and that the said particles consist of short fibres or grain-, shell- or film-pieces or flakes, which particles are bonded together by polymeric micro-strands, e.g. consisting of coagulated gluten or a natural or synthetic rubber as produced by coagulation of a latex.

28. A product according to any of claims 1 to 24, characterised in that B is or contains a gel based on a polymer belonging to the group of carbohydrates or carbohydrate related compounds.

29. A product according to claim 1, characterised in that B comprises a polymer and the boundary cell walls of B extending in a generally z direction are molecularly oriented in the general z direction.

30. A product according to claim 1, characterised in that A is a juice optionally in form of a soft gel or with a thickening agent and being flowable, and that A contains dissolved sugar.

31. A product according to claim 1, characterised in that A is a juice optionally in form of a soft gel or with a thickening agent, and that A contains hydrolysed proteins to give it taste and nutritional value comparable to meat.

32. A product according to claim 1, characterised in that A contains a pulp of short protein fibres or pieces of protein film.

33. A product according to claim 1, characterised in that A is a cultured milk product.

34. A product according to claim 1, characterised in that A is marzipan.

35. A product according to claim 1, characterised in that A is a paste based on meat.

36. A product according to claim 1, characterised in that the A component contains gas.

37. A bread or cake product according to claim 36, characterised in that A is based on expanded and baked starch and B is based on protein.

38. A product according to claim 36 characterised in that B comprises cheese.

39. A product according to claim 1, characterised by containing two different A-components, A1 and A2.

40. A product according to claim 39 in which A1 is a waterbased solution or gel or contains such solution or gel as matrix for solid particles, and A2 is fat- or oil-based or contains fat or oil as matrix for solid particles.

41. A three dimensional solid (including viscoelastic solid) food product elongated in at least one dimension (the z-dimension) and consisting of at least two components having different visual appearance which have been coextruded to become interspersed with one another in which there are segments of A and segments of B, characterised in that the or each B component is a solid (including a viscoelastic solid) at 20°C the or each A component is a solid (including a viscoelastic solid 20°C), the segments of A are arranged in at least two mutually distinct rows extending generally in the z-direction, and in which the rows of A and interspersed B are visible at at least one surface of the product extending in a general xz plane.

42. A product according to claim 41 in which the thickness of the segments of A and the segments of B are attenuated close to the border between two rows is as compared to their thickness at points distant from the boundary cell walls (where the thickness at any point is the shortest distance across the segment at that point) and in which the segments are dragged out so as to form an acute angle of less than about 45° with the z-direction in the xz plane.

43. A product according to claim 41 or 42 in which A and B consist of one of the following combinations:

a) darker chocolate/ligther chocolate

b) chocolate/marzipan

c) chocolate/caramel

d) two differently coloured gums or fruit gels.

44. A method of manufacturing by coextrusion in an extrusion die a food product in which the components are extruded in a z-direction from the extrusion die, and in which at least one extrudable component A' is formed into a flow through a channel and an extrudable component B' is formed into a flow through a channel, the flow of B' being x-wise adjacent to the flow of A', x being transverse to z, in which the flows of A' and B' exit from the channels through exits after which, the flows of A' and B' are regularly divided in a generally x-direction by a dividing member to form at least two rows of flows of A' and B' separated in the x-direction, in each of which row the flows of A' and B' segmented in the z direction and in which in each said row a segment of flow of B' is joined upstream and downstream to each segment of flow of A' whereby B' segments are interposed between adjacent A' segments in the z direction and in which adjacent rows are joined to one another along their yz faces, each row of segmented flows of A' forming a row of cells of A' extending generally in the z direction and wherein after the joining of the segmental flows B' is transformed to a solid material (including a viscoelastic solid) B, or, if B' is already viscoelastic, is transformed to a material B having a compressional yield point which is at least twice that of B'.

45. A method according to claim 44 in which after the said joining the material A' is expanded to at least twice the volume of A', or, if A' is plastic, pseudoplastic or viscoelastic is transformed to a material A having a lower yield point than the yield point of A' by a factor of at least 2 or to a fluid, or, where A' is a fluid, is transformed to a fluid A having an apparent viscosity less than half that of A'.

46. A method according to claim 44 or claim 45, <u>characterised in that</u> the extrusion is carried out at an elevated temperature and the transformation of B' takes place by cooling.

47. A method according to claim 44 or claim 45, characterised in that the said transformation of B' takes place by coagulation or gel formation.

48. A method according to claim 47, characterised in that the coagulation or gel formation is established by heating.

49. A method according to claim 47, characterised in that prior to the coextrusion process B' is formed as an extrudable material by disruption of a continuous, firm gel structure, and after the end of the coextrusion the continuous firm structure of this gel is reestablished by heating followed by cooling, or, if the gel is adequately thixotropic, spontaneously or upon storage.

50. A method according to claim 47, characterised in that the coagulation or gel formation is carried out by chemical reaction.

51. A method according to claim 50, characterised in that when the gel formation can be made sufficiently slow, the gelling reagent or coagulant is incorporated into B' prior to the coextrusion process.

52. A method according to claim 51 in which the reagent or coagulant is incorporated into solid particles suspended in B'.

53. A method according to claim 51 in which the gel formation or coagulation is enzymatic, for instance involving a protease such as rennin to break down and coagulate milk protein.

54. A method according to claim 47, characterised in that the gel formation or coagulation is established by including a reactant in the A', this reactant gradually migrating into B' component when the components are brought together in the coextrusion die.

55. A method according to claim 54, characterised in that the transformation partly occurs by precipitation in the B' of an inorganic salt, e.g. calciumphosphate, formed by reaction between ions in A' and ions in B'.

56. A process according to claim 51, characterised in that by a chemical reaction preformed solid particles are coagulated to continuous firm material.

57. A method according to claims 44 or claim 45 in which B' is water-based and the transformation of B' takes place by cooling to a temperature below the freezing range of B'.

58. A method according to claim 44 or claim 45, characterised in that during the extrusion B is mainly in the form of a firm material in particle form suspended in water, and after the end of the extrusion at least a part of the particles are first fused and then transformed by cooling to make the material cohesive.

59. A method according to claim 44 or claim 45, characterised in that in order to operate the extrusion process with A' in suitable extrudable state but achieve a more flowable consistency or lower yield point of A in the final product, A' is cooled prior to the extrusion sufficiently partly to solidify (including precipitate) a major portion at least of the material in A' as particulate suspended solids and after the extrusion the particulate solids are melted or redissolved.

60. A method according to claim 44 or 45 characterised in that in order to operate the extrusion process with B' in suitable extrudable state but achieve a more flowable consistency or lower yield point of B in the final product B' is cooled prior to the extrusion sufficiently partly to solidify (including precipitate) a major portion at least of the material in B' as particulate suspended solids and after the extrusion the particulate solids are melted or redissolved.

61. A method according to claim 60 in which B1 and B2 are formed of the same composition but are of different materials.

62. A method according to claim 44 or claim 45, characterised in that in order to operate the extrusion process with A' in suitable extrudable form but achieve a more flowable consistency of A in the final product, A' is applied to the extrusion process in said state by including in A' a polymer in dissolved or suspended particulate form, which is depolymerised at least in part after finalisation of the extrusion process.

63. A method according to claim 62, characterised in that the depolymerisation process is enzymatic.

64. A method according to any of claims 44 to 63 which A' is formed into at least two flows separated from one another in the x direction and in which B' is formed into at least two flows separated from one another in the x

direction and in which flows of B' are interposed between part of adjacent flows of A'.

65. A method of coextruding two materials A' and B' in an extrusion die in which at least one extrudable component A' is supplied from a reservoir for A' and is formed into a flow through an extrusion channel to an exit for A' from the channel, and at least one extrudable material B' is supplied from a reservoir for B' and is formed into a narrow flow through an extrusion channel to the exit for B' from the channel in which the flows of A' and B' are each divided at or after the respective channel exits to form segments of respective extrudates each by a dividing member which moves relative to the extruder exit from a first position in which the respective channel exit to a second position the dividing member has traversed the entire channel exit, and the flows of both A' and B' out of the extrusion channels are intermittent in nature, controlled either by providing a ram close to or within each channel which drives the flow intermittently or by opening a valve between the inlet to the respective extrusion channel and the reservoir from which the component is supplied under pressure, the movement of the ram or the opening of the valve, as the case may be, being co-ordinated with the relative movement between the dividing members and the channel exits such that material is driven through the exits while the relative movement is stopped in said first and second positions, but is not driven through the exits during the change of positions.

66. A method according to claim 65 in which each ram is operated in a series consisting of more than one inward step, preferably at least 5 inward steps, for instance up to 20 inward steps, and in which after a series of inward steps the ram is retracted.

67. A method according to claim 65 or claim 66 and in which A' is fed from the respective reservoir into a feeding slot which feeds into each of the channels for A', and B' is fed from the respective reservoir into a feeding slot which feeds into each of the channels for B' and in which a single ram is driven to the feeding slot to drive material through the slot and in which the ram is driven into the feeding slot preferably in a series of more than one inward step; preferably at least 5 inward steps, for instance up to 20 inward steps, and in

which, after a series of inward steps the ram is retracted and the feeding slot filled with extrudable material from the respective reservoir.

68. A method according to any of claims 65 to 67 in which there is a segment of flow of B' joined both downstream and upstream to each segment of flow A' is joined to.

69. A method according to claim 68 in which at least two x-wise adjacent z-wise extending rows of segments of A' and segments of B' are joined to one another along their generally zy faces.

70. A method according to claim 44 or 69 in which the rows are joined in a collection chamber and in which the sheet that is formed is preferably taken off on a conveyor.

71. A method according to claim 44 or claim 68 in which, after the exit from the extruder B' is modelled around A' segments so as to surround the A' segments substantially completely in an xz plane.

72. A method according to claim 71, <u>characterised in that</u> the said modelling is effected by selecting a B' which under the process conditions is a fluid or has a compressional yield point which is significantly lower, preferably by a factor of at least 2, than that of A', and if this provision is not sufficient to avoid sticking of the A-component to the dividing members, further adding a adding a food acceptable release agent such as e.g. cream to the A-component.

73. A method according to claim 68 or 71 , <u>characterised in that</u> in order to establish or facilitated the modelling of component B' around the segments of component A' flows of component B' are merged with each flow of A' before this meets the extruder orifice, this merging being on both sides (in the x direction) of A' to form a composite flow of B'A'B' configuration.

74. A method according to claim 73 in which there are several x-wise separated composite flows B'A'B' and the orifices through which such composite B'A'B' streams are extruded alternate (generally along the x-direction) with orifices through which plain B component is extruded, whereby immediately after the dividing the segmental streams will consist a transverse row of B'A'B' segments alternating with B' segments.

75. A method according to claim 72, in which there are two B' components B1' and B2' to become modelled together around each segment of A', and in which B1' is merged with A' to form composite flows B1'-A'-B1' as defined in claim 73, characterised in that B1' in a similar manner is merged with B2' to form composite flow B1'-B2'-B1', and the orifices for the composite B1'-A'-B1' flows alternate (in a generally x-direction) with the exits for the composite B1'-B2'-B1' flows whereby immediately after the dividing the segmental streams will consist of a transverse row B1'-A'-B1' segments alternating with B1'-B2'-B1' segments.

76. A method according to claim 73, characterised in that the said merging is carried out in such a way that there is also formed a B'A'B' configuration when the composite stream is viewed in xy section through A, or optionally a configuration with a longer sequence of alternating B' and A' segments, B' being at the beginning and end of this sequence.

77. A method according to any of claims 44 to 76 in which each dividing member reciprocates relative to the or each extruder exit.

78. A method according to claim 77 in which the dividing members move in a plane, or on a circular cylindrical surface.

79. A method according to claim 78 in which x is substantially vertical and y is substantially horizontal and in which the reciprocation is in a substantially vertical plane (xy plane) or is about a horizontal axis.

80. A method according to any of claims 44 to 79, characterised in that the dividing members are installed in fixed dieparts, while the assembly of channels and orifices moves.

81. A method according to any of claims 44 to 79, characterised in that the orifices are installed in a fixed diepart, while the dividing members are installed in a reciprocating or rotating diepart.

82. A method according to any of claims 44 to 81, characterised in that each orifice is arranged in close proximity to or directly contacting the or each dividing members, whereby the dividing takes place by the shear between the exit walls and the dividing member.

83. A method according to claim 82, characterised in that the dividing of each flow to segments is performed by a cutting action.

84. A method according to claim 83, characterised in that the cutting is performed by forming the upstream end of the or each dividing member generally as a knife at least on one x-directed side of the dividing member, the edge of the knife pointing generally in a direction parallel to the said relative movement.

85. A method according to claim 83 or 84, characterised in that the cutting is performed by forming the or each of the orifices walls generally as a knife at least on one x-directed side, the edge of the knife pointing generally in a direction parallel to the said relative movement.

86. A method according to claim 83 or 84, in which to enhance the effect of cutting, the or each orifice and/or the or each dividing member performs relatively fast and relatively small vibrations relative to each other generally in the y-direction these vibrations being in addition to the slower and bigger reciprocations along the direction defined by the line of orifices, whereby the knives perform a sawing action.

87. A method according to claim 65 in which the pressure in each reservoir is controlled in coordination with the movement of the rams whereby extrudable material is driven from the reservoir as the ram is retracted but is not driven from reservoir as the ram is driving material through the channel.

88. A method according to claim 87 in which there is a non-return valve between each reservoir and the respective channel preventing return of material in the channel-reservoir direction.

89. A method according to claim 88 in which the non-return valve is at the inlet into each channel.

90. A method according to claim 63, characterised in that the division between the channels for A' and the division between the dividing members are adjusted to each other and at least component A' is extruded in a rhythm syncronized with the relative reciprocation or rotation between the orifices and dividing members in manner to produce maximum driving force on the

component while each of the orifices for the component is aligned with a space channel formed between a pair of dividing members.

91. A method according to claims 67 and 80 in which the assembly of channels and orifices is pressed against the fixed assembly which comprises the feeding slots during refilling of the channel with extrudable material and pressure is released at least in part while the movement of the movable assembly takes place.

92. A method according to claim 44 or 64, characterised in that in the dividing process a layer of B' is formed on each generally xz face of the product by making the or each orifices from which B' flows extend beyond in the y direction the internal orifices from which A' flows whereby B' extruded through the orifice will be sheared out to form said layers.

93. A method according to any of claims 44 to 92, characterised in that in the dividing process there is also interposed one or more layers of B' between adjacent segments of A' separated from one another in the y-direction by making each internal orifice for A' interrupted at one or more locations along the y axis without making the orifices for B' interrupted, whereby the shear will establish the interposing and formation of the layer or layers of B' extending in a generally xz plane.

94. A method according to claim 93 in which the or each orifice for A' are provided with ribs extending across the exit in a generally x direction to create the said interruptions, and in which B' is sheared over the surface of A' segments by provision of shear plates each of which is aligned to be in the same generally xz plane as the respective ribs.

95. A method according to claim 75, characterised in that B2 is formed into a gel at least in part while it proceeds as flows towards the dividing process.

96. A method according to claim 65, characterised in that a lubricant capable of forming a harmless part of the product is injected around the or each said ram in amounts sufficient to follow the extrudable component acted on by the ram device, thereby also lubricating the walls of each channel through

which the component is extruded to significantly reduce the backpressure created by the extrusion through the channel.

97. A method according to claim 73 in which the merging of A' and B' flows takes place in an internal die comprising a central channel through which A' flows and a peripheral channels on each x-wise side of the central channel through each of which B' flows the central channel having valve means allowing closing of the central channel to minimise flow of B' into the central channel.

98. A method according to claim 97 in which the value means are actuable by controlling the pressure in the flows of A' and B' and preferably comprise springy blades extending along each side of the central channel joined thereto by fluid tight, joins along one long blade edge, the blades being of suitable size and springiness that they meet at their opposite long edges to close the channel.

99. A method of manufacturing by coextruision of a food product in sheet, ribbon or filament form, which product consisting of at least two components A and B, segments of B being in contact with segments of A, in which flows of A' and B' are coextruded from orifices of an extrusion die and, after extrusion, B' is transformed to a solid material (including a viscoelastic solid) B, or, if B' is already viscoelastic, is transformed to a material B having a compressional yield point which is at least twice that of B', in which B' is transformed by coagulation or gel formation initiated by a coagulant or gelling reagent incorporated in A'.

100. A method according to claim 97 in which the coagulant or gelling reagent is an enzyme, preferably a protease, for instance rennin.

101. A method according to claim 98 in which B' comprises a protein, for instance milk protein.

102. Apparatus suitable for carrying out a process according to claim 44, comprising an extrusion die having channels for flow of two different extrudable materials and orifices for exit in a generally z direction of material from the channels which are separated from one another in the x direction, further comprising dividing members capable of producing at least two rows of flows of extrudate by moving across the orifices to divide the flows in a

generally x direction, and comprising further means for subjecting the product to conditions to transform components of the product form a relatively soft material to a relatively hard material.

103. Apparatus suitable for carrying out a process according to claim 65, comprising an extrusion die having channels through which at least two different materials may flow, means for driving the material through the channels and out of orifices which are separated from one another in the generally x direction, and having dividing members which are capable of moving across the orifices to divide the flows of extrudate therethrough in a generally x direction, in which the movement of the dividing members and the driving of the material through the channels are controlled so that material is diriven through the orifices while relative movement between the dividing members and the orifices is stopped.

104. Apparatus according to claim 102 or 103, further having features as described herein.

105. Apparatus as described herein and substantially as illustrated in the drawings.

Fig.1a.

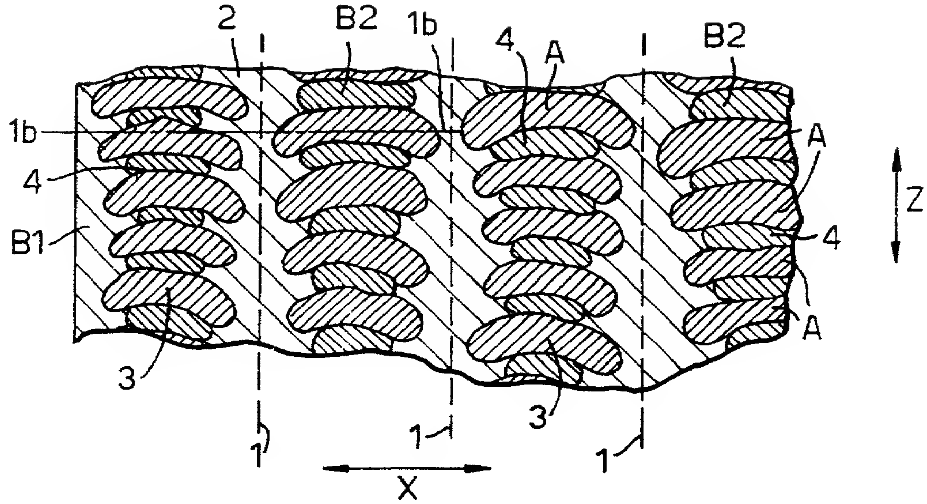


Fig.2.

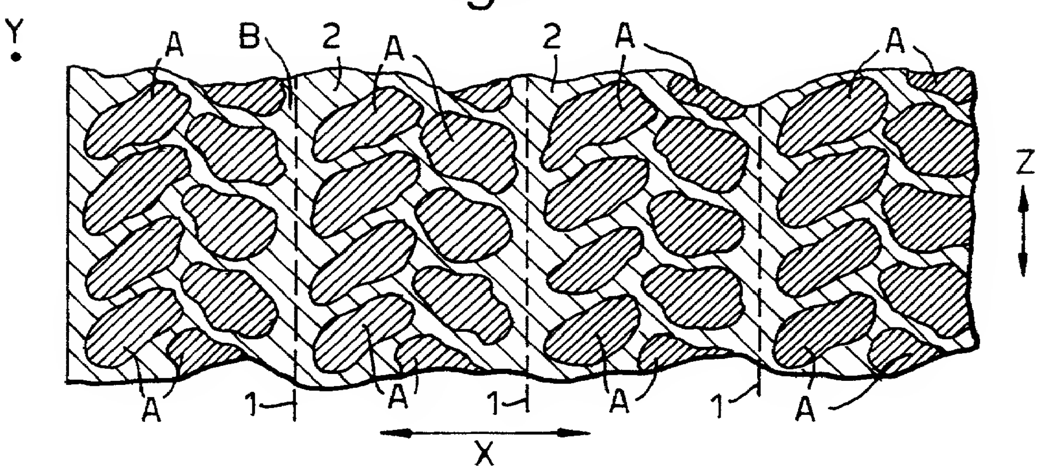


Fig.1b.

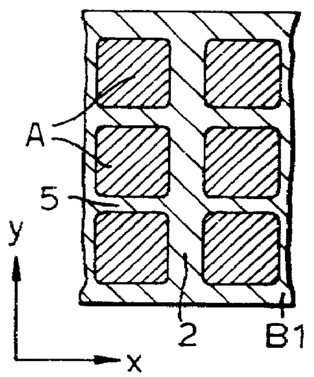


Fig.1c.

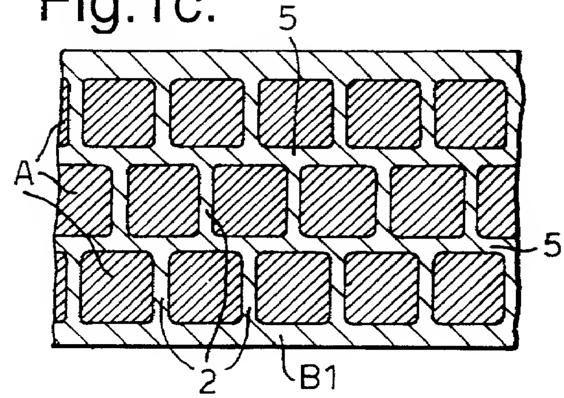


Fig.3.

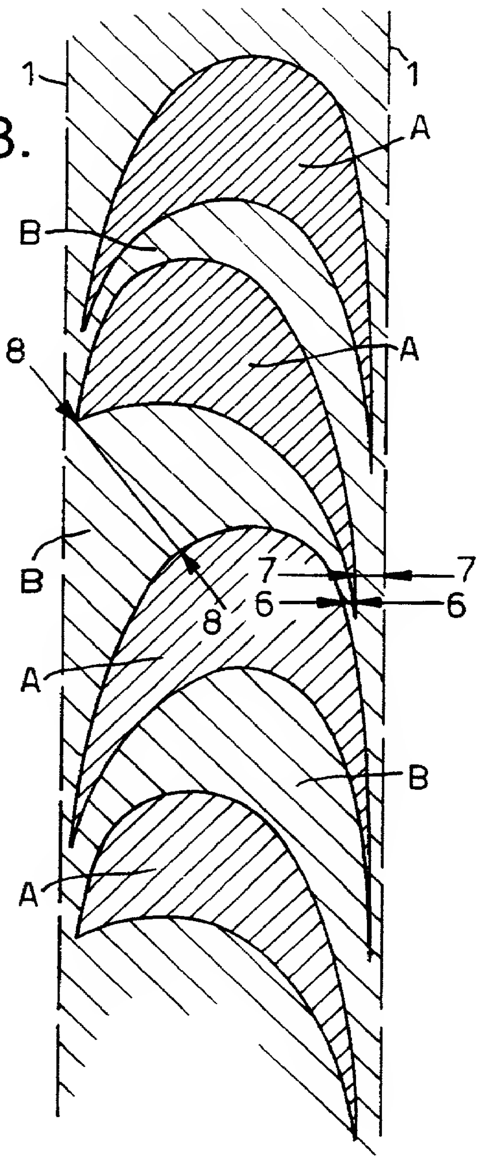


Fig.1d.

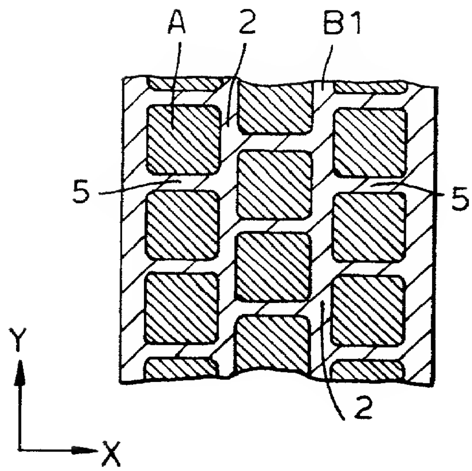


Fig.4.

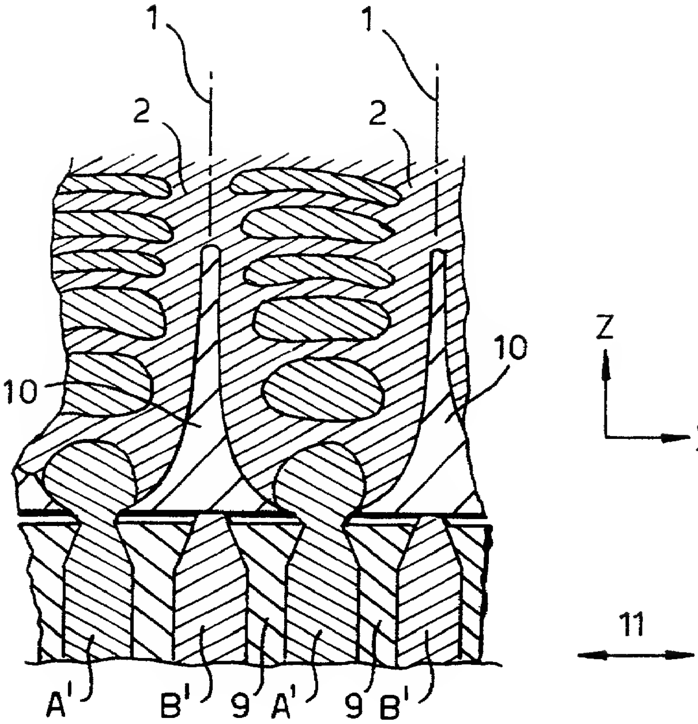


Fig.5.

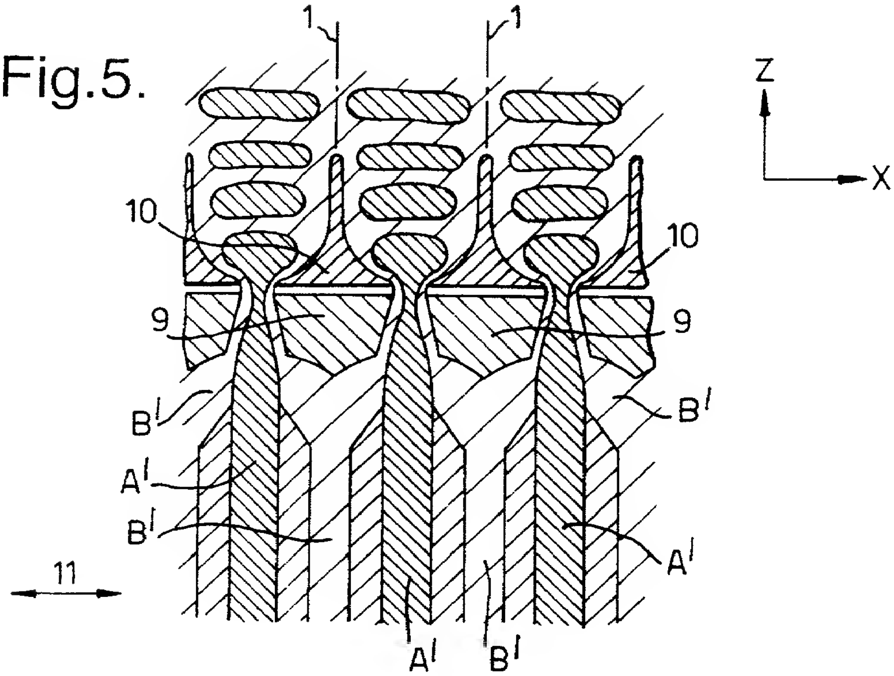


Fig.6a.

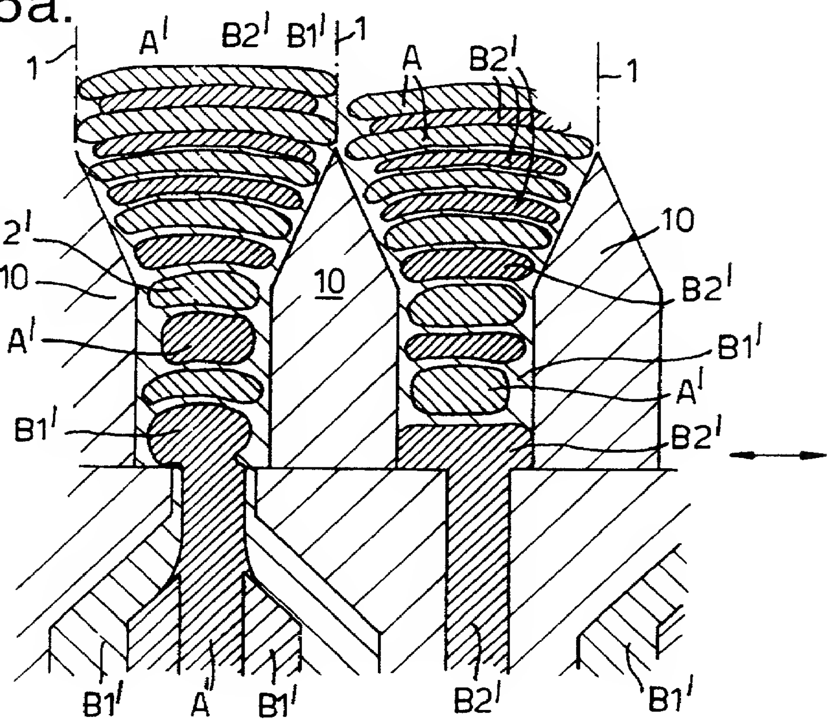


Fig.6b.

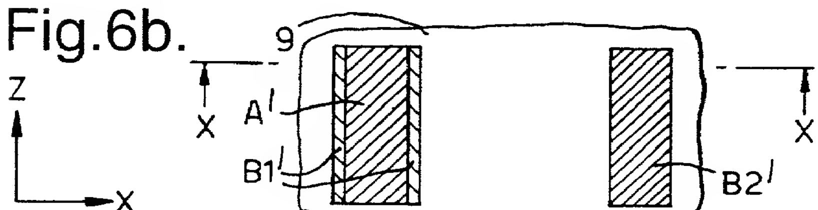
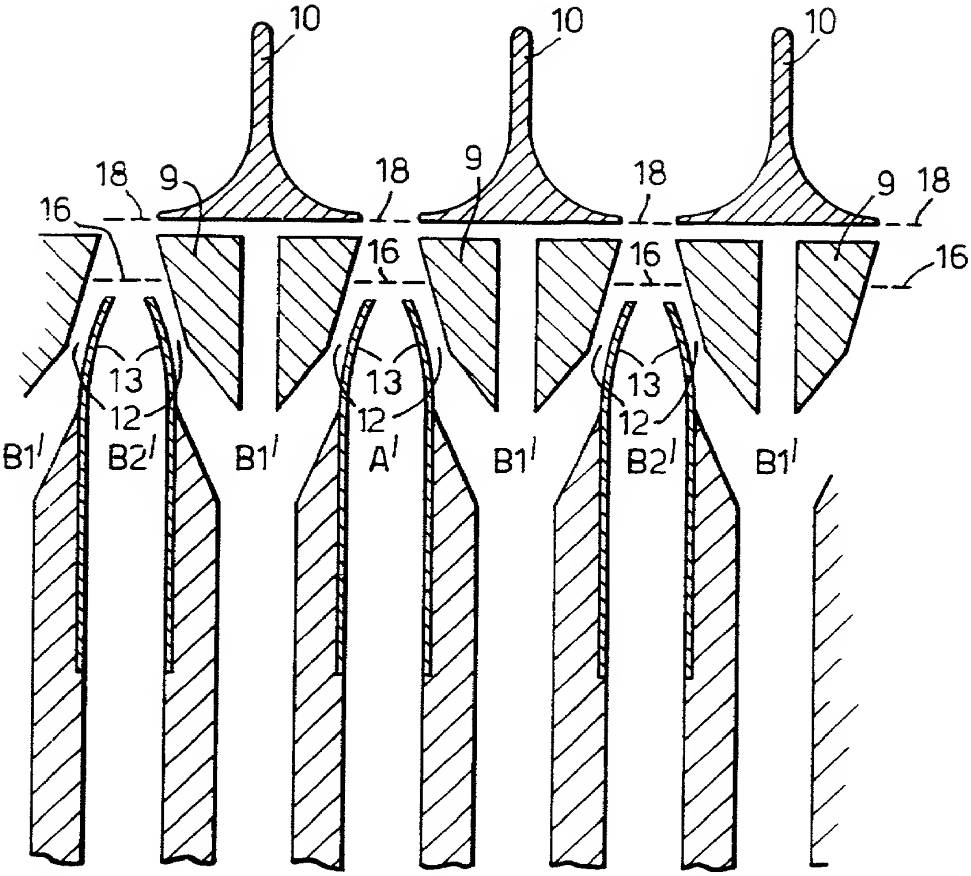


Fig.7a.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B2'
B1'

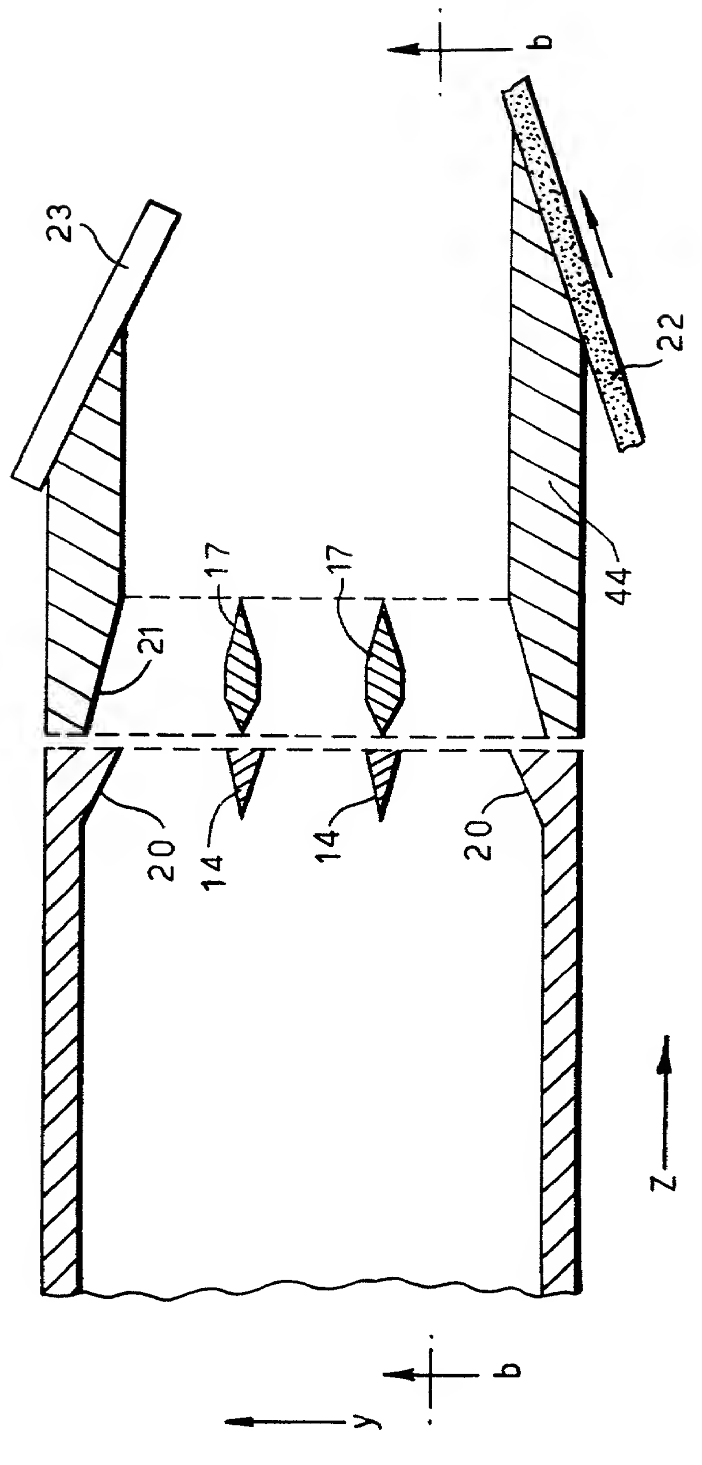
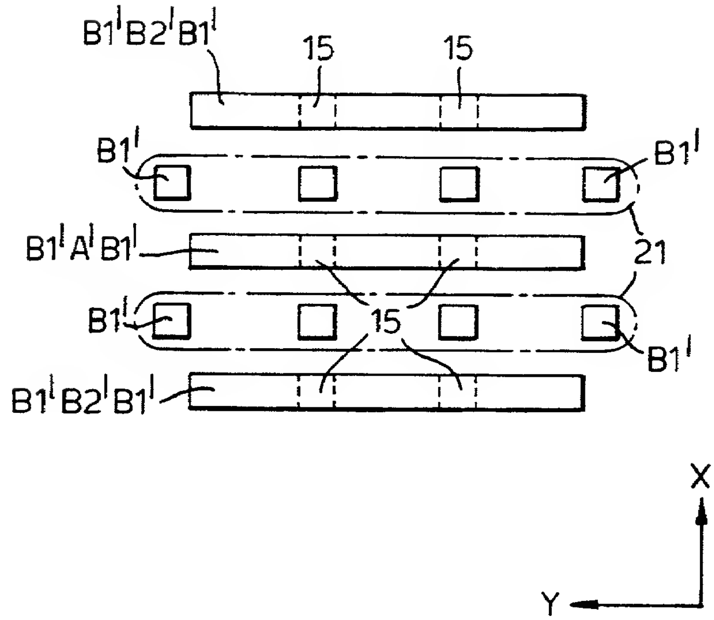


Fig.7 b.

Fig.7c.



09/926310

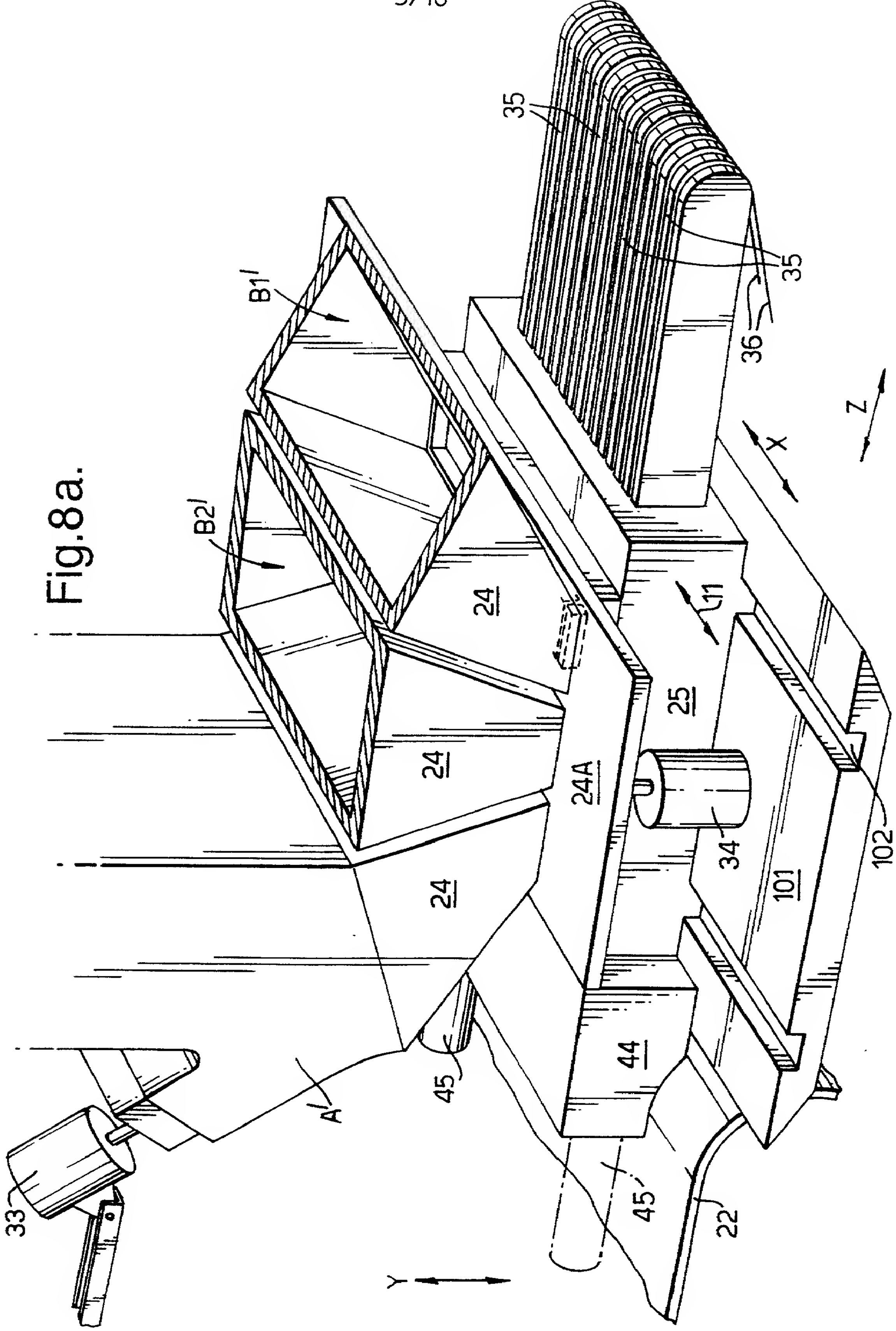
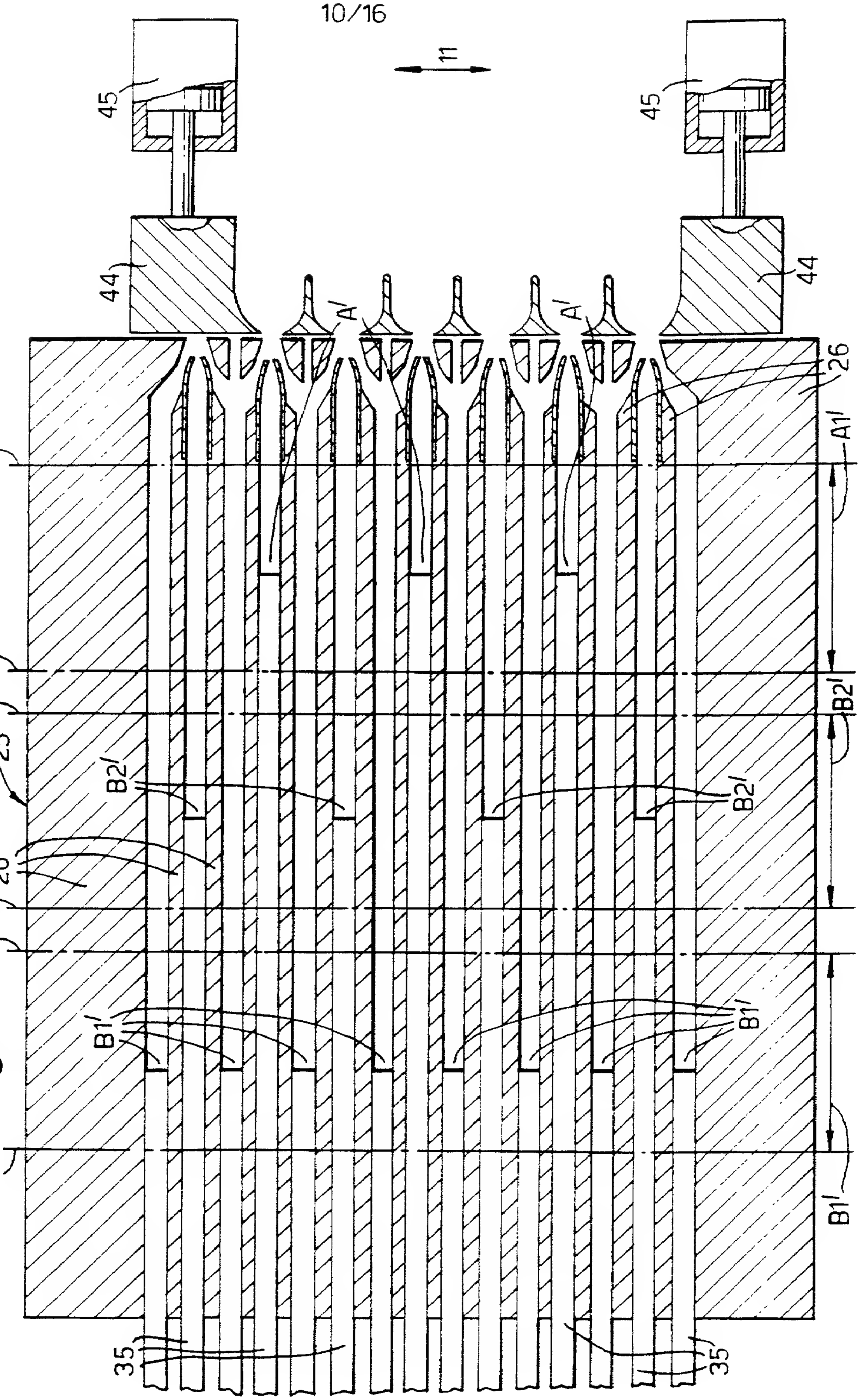


Fig.8a.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44
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A'
A'
26
A1'
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Z
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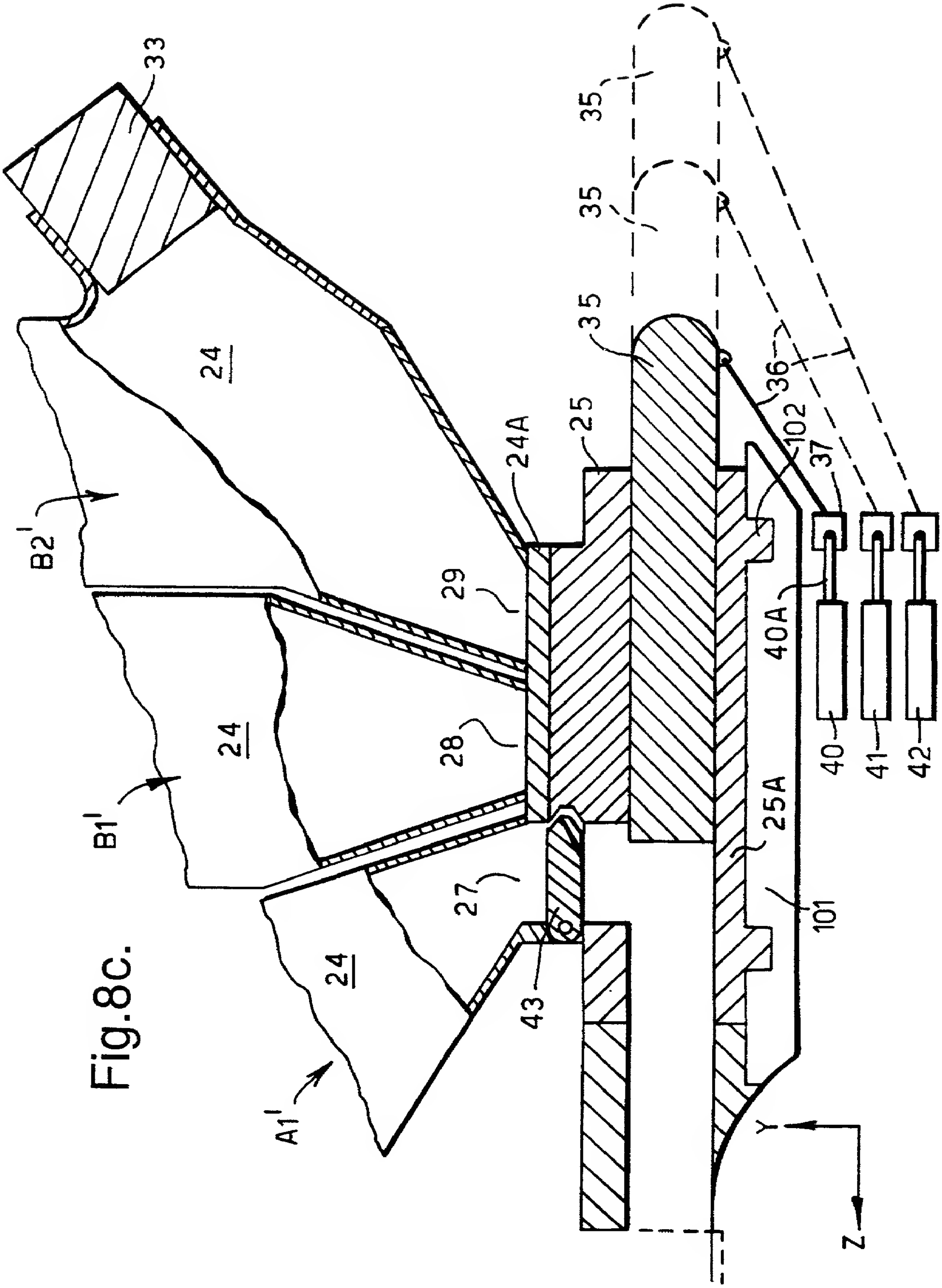
B2'
26
31
32a
B1'
B1'
32
B1'
35
35

Fig.8b.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A1'
Y
Z

Fig.8c.

Fig.8d.

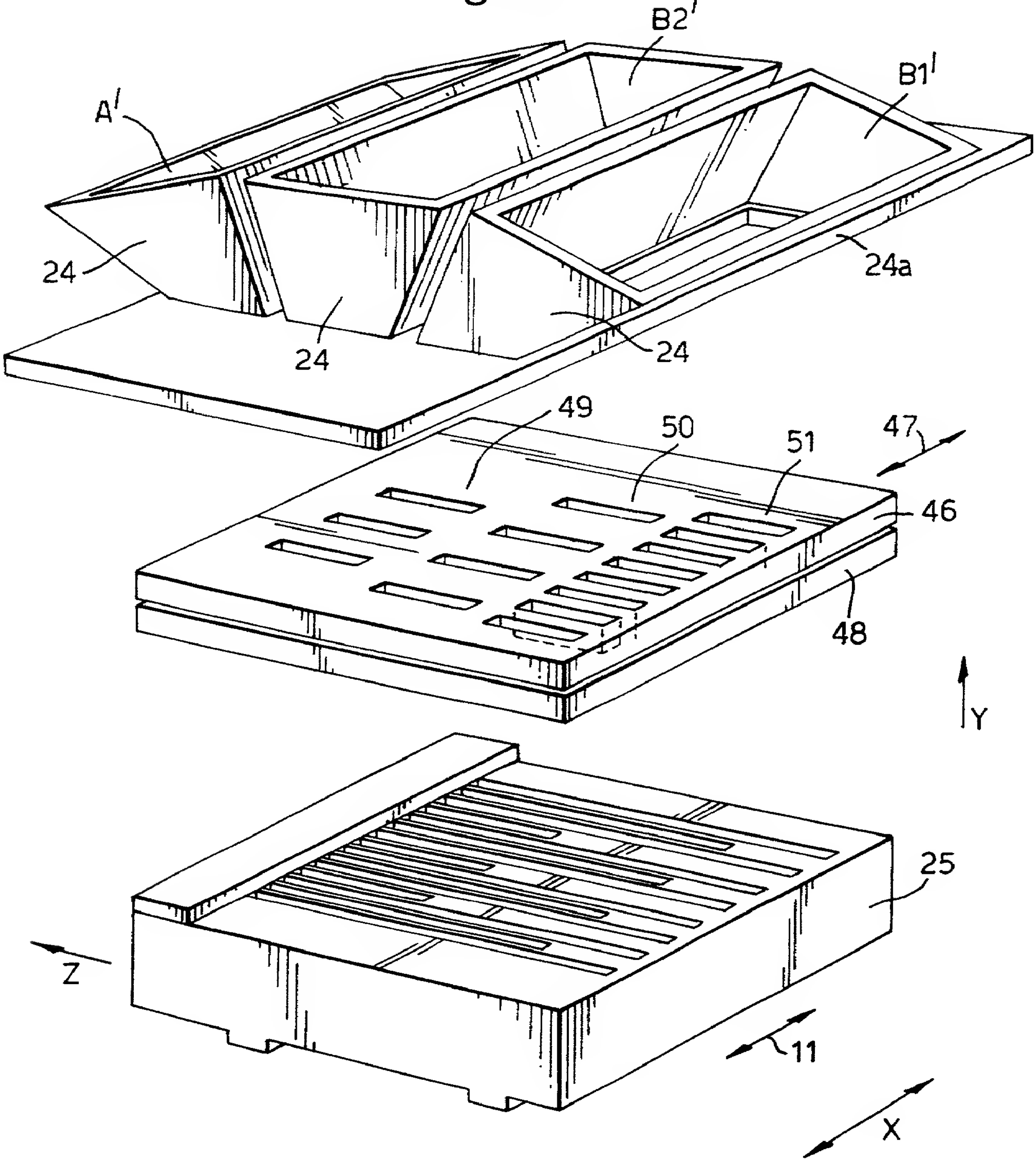


Fig.9.

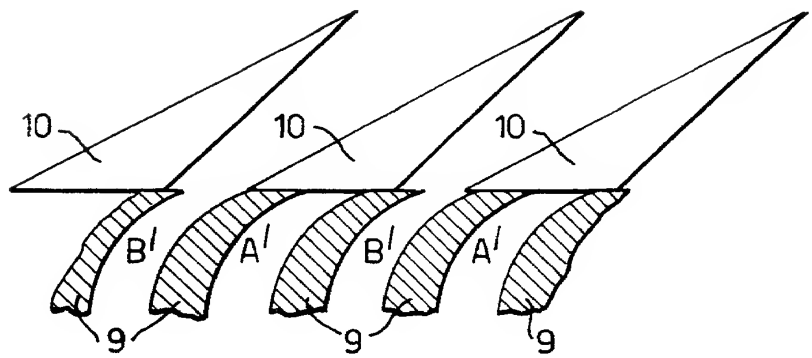
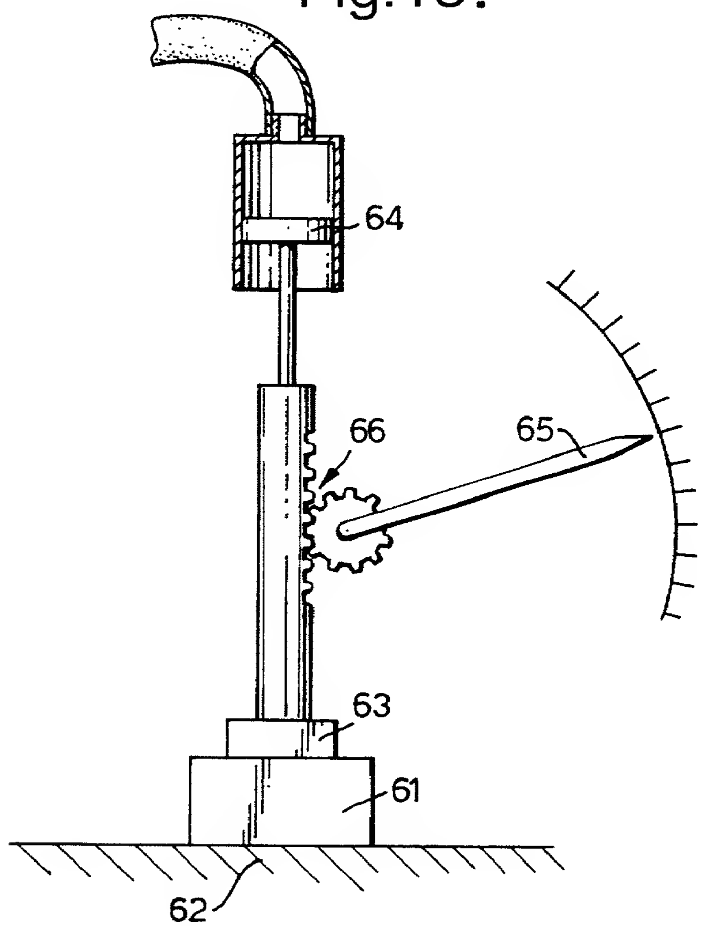


Fig.13.



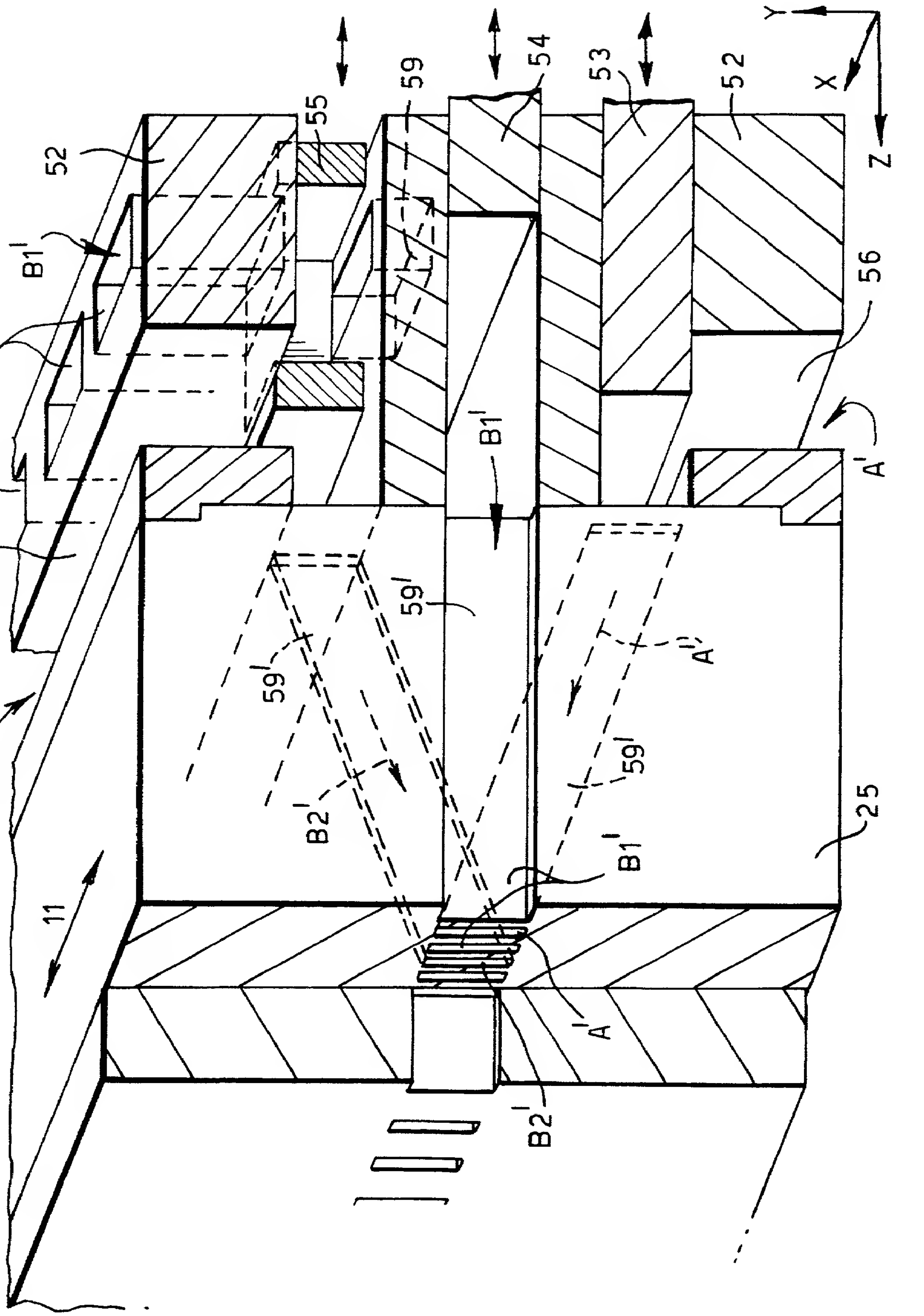


Fig.10.

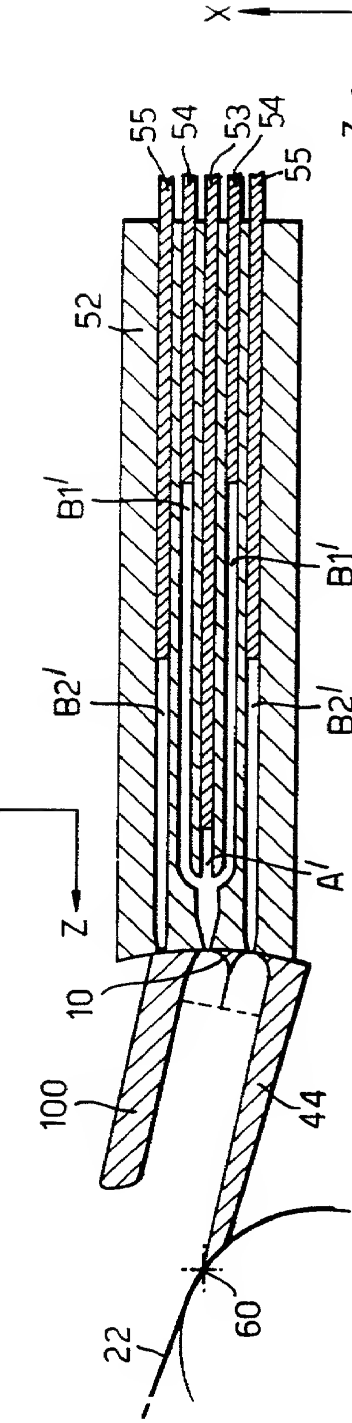


Fig.11a.

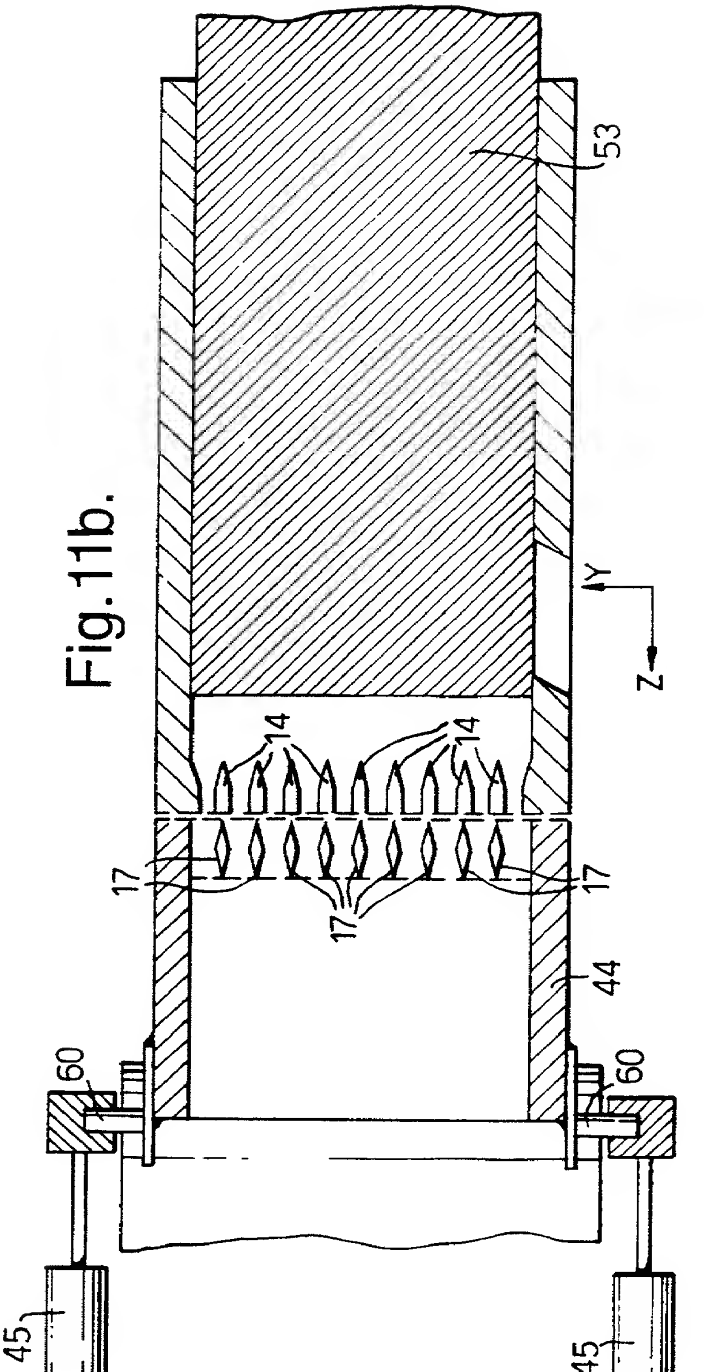
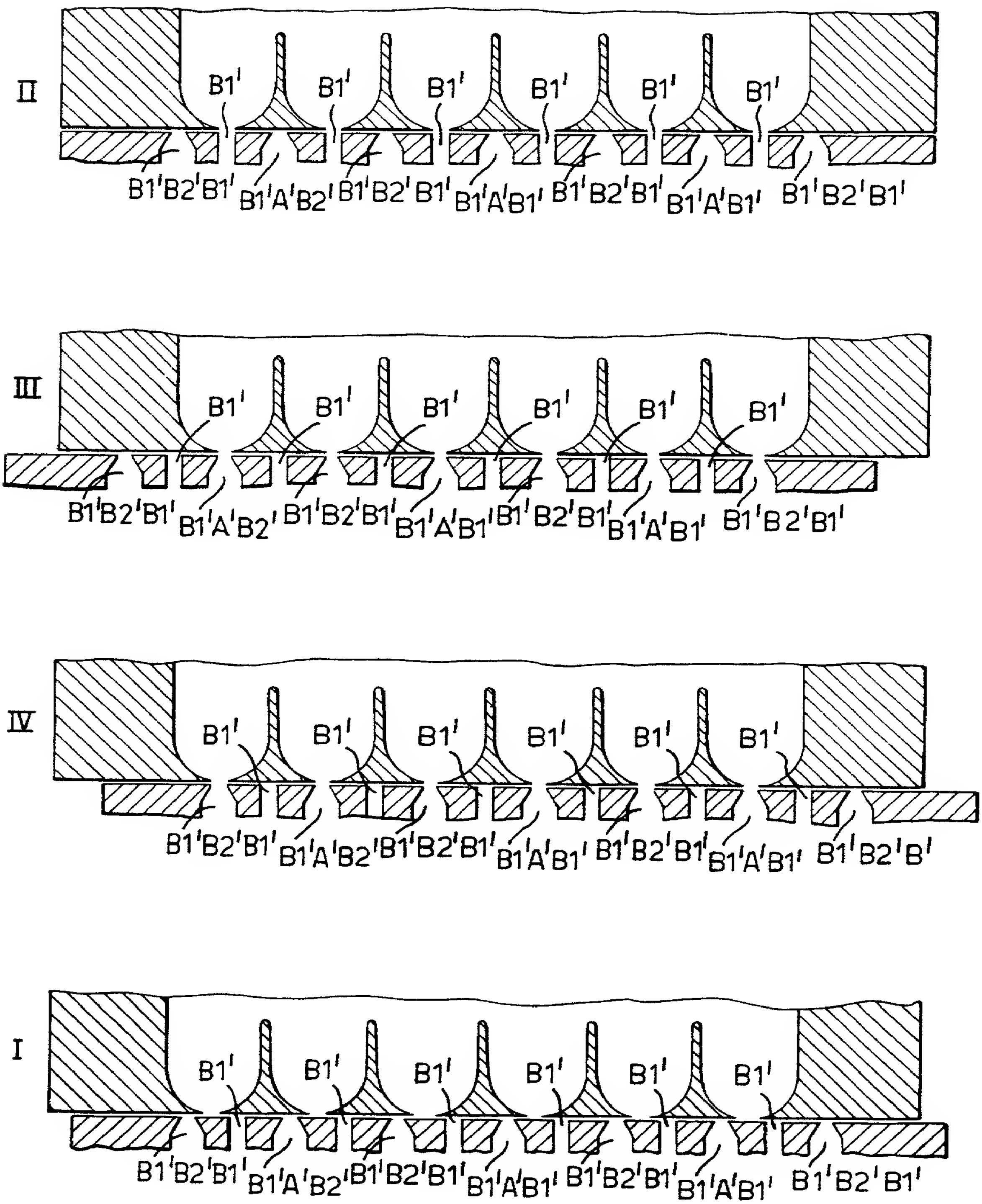


Fig.11b.

Fig.12.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B1'
B1'B2'B1' B1'A'B2' B1'B2'B1' B1'A'B1' B1'B2'B1' B1'A'B1' B1'B2'B1'
IV
B1'
B1'B2'B1' B1'A'B2' B1'B2'B1' B1'A'B1' B1'B2'B1' B1'A'B1' B1'B2'B'
I
B1'
B1'B2'B1' B1'A'B2' B1'B2'B1' B1'A'B1' B1'B2'B1' B1'A'B1' B1'B2'B1'

DECLARATION FOR PATENT APPLICATION

Docket No. 3330

As a below named inventor, I hereby declare that:

My resident, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled FOOD PRODUCT WHICH ARTIFICIALLY HAS BEEN GIVEN A CELL-LIKE STRUCTURE BY COEXTRUSION OF SEVERAL COMPONENTS, AND METHOD AND APPARATUS FOR MANUFACTURING SUCH FOOD PRODUCT, the specification of which

(check one) is attached hereto.
XXX was submitted to the USPTO by the Internation Bureau of the PCT by notice dated October 19,2000 as Application Serial No. PCT/EP 00/03713
and was amended on ______________ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulation, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior International Application(s): Priority Claimed

(Number)	(Country)	Date/Month/Year Filed)	Yes	No
PCT/EP00/03713	EUROPEAN PATENT OFFICE (GB)	13/APRIL/2000	YES	

claiming priority based on the following applications:

(Number)	(Country)	Date/Month/Year Filed)	Yes	No
9908444.4	GREAT BRITAIN	13/04/99 (13 APRIL 1999)	YES	
9912565.0	GREAT BRITAIN	28/05/99 (28 MAY 1999)	YES	

I hereby claim the benefit under Title 35, United States Code, §120 if any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.)	(Filing Date)	(Status--patented, pending, abandoned)
NONE		

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:
WILLIAM J. DANIEL, REG. NO. 16,585.
Address all telephones calls to WILLIAM J. DANIEL at telephone no. 703-536-4361.
Address all correspondence to WILLIAM J. DANIEL
6700 WOODLAND TERRACE
MCLEAN, VA 22101.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole or first inventor OLE-BENDT RASMUSSEN

Inventor's signature Ole-Bendt Rasmussen Date Sept. 28, '01
Residence Sagenstrasse 12, CH-6318 Walchwil/Zug, SWITZERLAND Citizenship DENMARK
Post Office Address Same as residence address

Full name of second inventor NONE
Inventor's signature ______ Date ______
Residence ______ Citizenship ______
Post Office Address ______

(Supply similar information and signature for third and subsequent joint inventors.)

Form PTO-FB-A110